

**Knowing more than you think you know:  
Maximising preserved memory in people with  
acquired memory deficits to enhance everyday  
learning and recall.**

Mary Todd

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## ABSTRACT

Implicit memory is generally preserved in people with organic memory damage and has been shown in laboratory studies to mediate diverse unconscious memory abilities. These include procedural skill acquisition and ‘priming’ which results in the recall of episodic information based purely on recent exposure - information which is differentially facilitated by the type of cue presented at retrieval. The work described in this thesis explores the optimisation of these retained aspects of memory, which have proved difficult to apply to the everyday lives of people with organic memory difficulty: first in the learning of new useful skills and secondly in the enhancement of episodic recall during everyday conversation. The first study, employed error-free learning, spaced repetition and individual coaching to teach two people with memory impairments to touch type to 30 words a minute, providing ecological validity to laboratory studies of skill learning in this group of people. The second study explored the hypothesis that implicit skill acquisition, gained under error-reduced conditions, may be further facilitated if explicit verbal instruction was withheld. There was no significant effect of omitting instructions. In a departure from skill-learning, a third study explored the effect of imaginal context reinstatement on free recall of a recent event. Also, for the first time, it investigated the cueing effect of different types of questions and verbal exchanges during a dyadic ‘questioning’ phase of a conversation about a recent event. There was no effect of context reinstatement on free recall. However, significantly more items were recalled in the dyadic phase using a protocol with predominantly open questions, over one containing a preponderance of closed questions. Across both conditions open questions were most effective as cues. Results provide ecological validity to laboratory findings from priming and cueing studies, suggesting that natural cues which arise spontaneously during conversation, can be manipulated to engender more recall. Theoretically, results of the cueing study indicate episodic memory failure is at least in part due to poor retrieval. Practically, tentative guidelines are presented for use by potential ‘conversation partners.’

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### PILOT STUDY

To tell or not to tell: Instruction-free learning as an adjunct to error-reduction in motor skill learning for people with explicit memory impairments.

An exploratory pilot study involving participants with normal memory was carried out in advance of the planned study: The research objective was to test the hypothesis that giving explicit instructions during the error-free learning of a perceptual motor skill task (golf putting) would affect the acquisition and retention, of the task. The effect on learning was to be analysed by comparing the putting scores at various distances from the hole and the effect on retention by comparison of the scores from the final learning trial and the test phase ten minutes later.

#### Aims and Rationale

1. To observe difference in performance (scores during learning and at test) between the explicit group, who will receive explicit verbal instructions before and during the task, and the implicit group who receive no explicit instructions.
2. To test the efficacy of the scoring system.
3. To ascertain how arduous the task may be for the target group.
4. To determine if any changes in the method need to be made, for example inclusion of rest periods, or fewer learning trials.

#### Participants

Four people with normal memory (one of whom had a brain haemorrhage 20 years ago) volunteered to take part in the pilot study.

#### Method

Four participants carried out the same putting task under error-free conditions. The error free conditions were induced by using a protocol which begins learning trials from very near the hole (25cms) and gradually moves further from the hole at 25 cm increments. This method induces error free learning by reducing errors to a minimum.

The participants putted the ball 50 times for each trial from distances of 25, 50, 75, 100, 125, 150 and 175 cms. At the conclusion of the trials the participants rested for ten minutes before the test phase, which involved 50 attempts to putt the ball into the hole from a distance of 175 cms. Scores in the form of number of holes missed were recorded at each stage.

The participants were divided into two groups. The explicit group were given standardised verbal instructions seven times: before the first trial and subsequently between each learning trial, but not before the test phase. No attempt was made to answer questions or to enter into dialogue on how the task was to be carried out. If asked questions the experimenter said : "This is all I am able to tell you."

The instructions were:

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#### Explicit instructions

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1. Keep your feet shoulder width apart and knees slightly bent.
  2. Place your right hand below your left hand when gripping the club handle.
  3. Move the club back a short distance then swing the club forward with a smooth action along a straight line.
  4. Allow the club to continue swinging a short distance after contact with the ball.
  5. Adjust the speed of your movement so that the correct amount of force is applied.
  6. When you hit the ball make sure that the putter head is at a right angle to the direction you want the ball to travel.
-

The second group – the implicit group – were given no explicit instructions on how to carry out the task. They were told just to do their best to get the ball into the hole as many times as possible.

The experimenter retrieved the balls and placed them at the correct distance for each shot.

### Materials

A practice golf putting mat, marked for the various trial distances, standard golf balls and putter were used. Score sheets were used to record missed holes.

### Results

Raw data are shown at Table 1:

Table 1: Scores of individual participants out of 50 for individual trials and test and out of a possible 400 overall score (including test).

| Condition<br>Trial | Explicit |      | Implicit |      |
|--------------------|----------|------|----------|------|
|                    | Exp1     | Exp2 | Imp1     | Imp2 |
| 25cm               | 46       | 50   | 49       | 49   |
| 50cm               | 44       | 48   | 50       | 46   |
| 75cm               | 41       | 48   | 45       | 43   |
| 100cm              | 33       | 39   | 44       | 38   |
| 125cm              | 26       | 40   | 42       | 46   |
| 150cm              | 16       | 39   | 44       | 38   |
| 175cm              | 23       | 41   | 36       | 41   |
| TEST               | 29       | 41   | 34       | 41   |
| TOTAL              | 258      | 346  | 344      | 342  |

Scores at test were higher for the implicit pair 34/50 and 41/50 than for the explicit group who scored 29/50 and 41/50. The participants with both the highest (346/400) total overall score and the lowest (258/400) overall score were both in the explicit group.

As was to be expected, all participants showed lower scores at further distances from the hole, as the task became more challenging. One participant's score between the last learning session improved, two remained the same and one decreased by two. From the point of view of the extent to which explicit instructions affect the course of learning, there was a noticeable reduction in the number of successful putts by participant Exp 1 after 125 cm, with a score of just 16/50 at 150 cms and 23/50 at 175 cms (the lowest scores in any trial by any participant). At this stage instructions had been received six and seven times.



These results may be in the normal range, or may reflect the imposition of explicit instructions. It is worth noting that SB, though reporting no memory problems, was the only volunteer in the group to have sustained brain injury and this may have been a factor in her result.

**Scoring system**

The score sheets which had been devised to aid scoring were found to be adequate.

**Changes to methodology**

The golf protocol takes around 45 minutes to administer and involves standing and moving the arms and torso when using the putter. To address the possible fatigue imposed by the requirements of the study it was decided that the following steps would be taken based on observation from the pilot study:

1. Before the study:

- a. The participants will be given written information pointing out the time needed to complete the study.
- b. Participant were to be told they can ask for a break at any time, sit down between trials or withdraw from the study at any point.
- c. They should be told to wear comfortable, low heeled shoes and non-restrictive clothing.

2. During the study:

- a) Participants will be offered the chance to sit down and rest between learning trials at 100 cms and 125 cms even if they have not asked for a break.
- b) They will also rest for ten minutes between the completion of the trials and the test phase.

The number of learning trials should not be decreased, because it is essential that the study include enough trials to enable perceptual motor learning to take place.

3. At the conclusion of the study:

- a) At the conclusion of the trials participants in the implicit group, will be asked whether they can describe any 'rules' of golf putting which they have learned during the trials. These will be written on the score sheets.

## APPENDIX II

### PAR-Q Health Questionnaire

RD 122

Please read the questions carefully and answer each one honestly, ticking the appropriate box or adding information if necessary. Your responses will of course be kept in the strictest confidence.

Name: \_\_\_\_\_ Postcode: \_\_\_\_\_

Contact tel no (mobile preferred) \_\_\_\_\_ email \_\_\_\_\_

Has your doctor ever said that you have had a heart problem?

No ☐ Yes ☐

In the past month have you had any chest pain when...

You were doing any activity No ☐ Yes ☐ You were resting No ☐ Yes ☐

Are you currently taking medication for...

A heart condition No ☐ Yes ☐

Any other problems No ☐ Yes ☐

Do you suffer from any bone or joint problems?

No ☐ Yes ☐

In the past year have you had any major illness or major surgery?

No ☐ Yes ☐

Have you ever been diagnosed with...

Diabetes No ☐ Yes ☐

Asthma No ☐ Yes ☐

Epilepsy No ☐ Yes ☐

Other problems No ☐ Yes ☐

Are you pregnant?

No ☐ Yes ☐ EDD \_\_\_\_\_

Have you recently had a baby?

No ☐ Yes ☐ How long ago? \_\_\_\_\_

Do you ever...

lose your balance because of dizziness or lose consciousness No ☐ Yes ☐

Are you feeling unwell at present due to cold, etc

No ☐ Yes ☐

If you have answered YES to one or more questions we may need you to contact your doctor before starting to exercise. If your health changes so that you may then answer YES to any of these questions, tell a member of staff as soon as possible.

I have read, understood and completed this questionnaire.

Any questions that I had were answered to my full satisfaction.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Signature of Parent/Guardian (if aged 16 – 17) \_\_\_\_\_



## CHAPTER ONE

### INTRODUCTION

*“ You have to begin to lose your memory, if only in bits and pieces, to realise that memory is what makes our lives...Our memory is our coherence, our reason, our feeling, even our action. Without it, we are nothing.”* Luis Buñuel, Spanish film maker (1900-1983).

#### 1.1 Rationale for the thesis

When the ability to remember is affected by brain damage the main casualty is explicit memory for information and events, encountered since the injury, which normally could be brought to mind and described. Yet despite their having difficulties with fact-based learning and everyday recall, laboratory work has revealed over decades that even people who are severely disabled in this way retain implicit memory abilities which continue to function normally, or near normally, below their level of awareness (e.g. Milner, 2005; Schacter, 1987; Squire, 2004; Wilson, 2009). The work described in this thesis makes an original contribution to knowledge by exploring the practical and social application of some aspects of this retained implicit memory, a so far untapped resource (Cavaco, Malec & Berquist, 2005), which has proved difficult to apply to the real life problems encountered by people with memory difficulties (Wilson, 2009). It is suggested that because implicit memory is unconscious, so that the rememberer is unaware of its effects, people with memory problems may, to their surprise, know more than they think they know.

Implicit memory underlies many everyday adaptive abilities seldom recognised as ‘memory’ by the person in the street. However the general public is on nodding terms with some types of implicit memory. For example on finding they can still perform a long since acquired task they may say it is ‘just like riding a bike,’ or when to their surprise they correctly answer a question with what they assume is just a ‘lucky guess.’ Both of these phenomena reflect attributes of implicit memory which, among other functions, underlies procedural learning of perceptual motor skills (e.g. Butters, 1987; Eslinger & Damasio, 1986; Milner, 1962; Milner, Corkin & Teuber, 1968; Starr & Phillips, 1970) and ‘priming,’ the phenomenon which results in correct responses being given to a cue based purely on recent exposure (e.g. Graf, Mandler & Haden, 1982; Hamann & Squire, 1997; Mayes & Meudell, 1981; Tulving, Schacter & Stark, 1982; Warrington & Weiskrantz, 1974). These seemingly incongruent abilities have two things in common: they show a non-conscious influence of past experience on current performance or behaviour (Schacter & Buckner, 1998) and they have been shown to function experimentally even in people with the most severe explicit memory difficulties. With some rare

exceptions, for example in Parkinson's Disease and Huntington's Disease, simple motor skills may be acquired in the laboratory without any memory of the learning process in people with amnesia (e.g. Butters, 1987; Eslinger & Damasio, 1986; Milner, 1962; Milner, Corkin & Teuber, 1968; Starr & Phillips, 1970). Additionally robust results from priming experiments demonstrate that people with amnesia give accurate responses on word stem completion tests, though they are unaware that they are remembering and may attribute their correct answer to a 'lucky guess' (e.g. Graf et al., 1982; Hamann et al., 1995; Mayes & Meudell, 1981; Tulving, et al., 1982; Warrington & Weiskrantz, 1974). Importantly, the observation that people with amnesia give a comparable number of correct answers to controls when they are asked to respond with the first word that comes to mind, rather than being asked to consciously remember, adds weight to the suggestion that this is a function of implicit verbal priming mechanisms and suggests that recall depends crucially on the participants' reaction to the way in which they are prompted (Graf & Mandler, 1984; Graf & Schacter, 1985). It is highly unlikely that the implicit memory functions underlying perceptual motor skill learning and priming, are mere artefacts of research. These functions must operate in everyday life but not necessarily in an optimal fashion. In terms of rehabilitation the task is to find ways in which they can be channelled and put to practical use for people with memory problems and those who interact with them.

## **1.2 Ethical Approach**

The high level of commitment required by the participants in the studies described in this thesis influenced the ethical approach of the researcher, which is characterised by a strong emphasis on designing-in elements which may be expected to contribute to *success on the task* rather than on strict control of individual variables. This approach, based on optimising the possibility of achievement, does not seek to answer questions about the precise contribution of the various strategies employed where the existing research base provided evidence for their individual efficacy.

The studies gained ethical approval from the Academic Research Degrees Board of the University of Bolton following discussion of issues of vulnerability, capability and the effort of taking part in repeat trials. All participants were considered to be capable of giving formal informed consent and did so. They were in addition reminded of this during each contact with the researcher and the purpose of the research was reiterated at the beginning of each study. Pilot studies were carried out on two of the tasks, using participants with normal memory, to test the appropriateness of the methodology in terms of the amount of effort required on the part of the participants and suitability of the scoring systems. (See appendices I & II).

Participants in the studies were volunteers from among clients at the charity, The Brain and Spinal Injury Centre (BASIC) in Salford, Greater Manchester, where the author has worked for ten years, teaching general memory strategies to groups and specific memory aids to individuals seeking to

gain or retain employment following brain injury. They consisted of a heterogeneous sample of people, of a wide range of ages whose brain injuries arose from different aetiologies, selected and/or matched solely on the basis of their scores on memory tests and their physical ability to carry out the tasks.

### **1.3 Thesis Structure.**

Chapter Two summarises the background and current position in memory research and memory rehabilitation and contains reviews of the relevant literature. The thesis concludes at Chapter Six with a general discussion of the work as a whole and the conclusions which may be drawn from it.

Three empirical studies are reported at Chapters, Three, Four and Five. The first two investigate the optimisation of everyday motor skill learning. The third differs in that it focuses on the possible contribution of different forms of questions and verbal exchanges which may be used as cues to benefit the recall of a recent event. Each study is prefaced by its own introduction and detailed literature review and concludes with a specific discussion. The studies are briefly summarised below.

#### *1.3.1 Teaching people with memory impairments to touch type: The acquisition of a useful complex perceptual - motor skill.*

The proposition under scrutiny in this study was whether or not people with memory impairment due to brain injury are capable of learning the complex perceptual-motor skill of touch typing to a useful level: in other words whether the observations of preserved abilities in perceptual motor skill learning using simple laboratory tasks (e.g. Brooks & Baddeley, 1976; Cohen, 1984; Cohen & Squire, 1980; Corkin, 1968; Gauggel & Fischer, 2001; Starr & Phillips, 1970;) apply to learning a real-world perceptual-motor skill, and crucially whether the skill proves robust and resistant to deterioration over time, in contrast to some other forms of implicit learning (Evans, Wilson, Schuri, Andrade, Baddeley, Bruna, Canavan, Della Sala, Green, Laaksonen, Lorenzi, & Taussik, 2000). It was hypothesised that touch typing could be especially useful to people with memory impairment, since it provides a sound basis for learning to use computers at work and at home, and as compensatory memory aids (Hunkin, Squires, Aldrich, & Parkin, 1998).

The aim of this study was to teach two people with memory impairments to touch type, on the basis that touch typing, while complex, is a perceptual - motor skill that theoretically could be acquired by people with preserved procedural memory, especially if they are taught in ways which maximise acquisition, for example using an error-free protocol, which has been shown to facilitate some types of learning (Evans et al., 2000). It was recognised that learning to touch type to a level of automaticity, as with other complex motor skills, could take weeks or months of patient, deliberate practice to achieve (Bower, 2000) and would require considerable commitment on the part of the participants. To give the best chance of success therefore teaching, needed to be carried out under optimal conditions, based on

current empirical evidence. To achieve this the methodology included the use of errorless techniques (Campbell, Wilson, McCann, Kernahan & Rogers, 2007; Lloyd, Riley & Powell, 2009; Maxwell, Masters & Poolton, 2008; Sohlberg & Turkstra, 2011). Learning conditions would also include, individual coaching (Clegg & Rowe, 1996; Maxwell, Masters, Kerr & Weedon, 2001; Wulf, Shea, & Whitacre, 1998), standardised repetition of sessions (Wickens, 1989), saturation of learning (Hauptmann, Reinhart, Brandt & Karni, 2005) and distributed practice (Baddeley & Longman, 1978; Duke & Davis, 2006; Ofen - Noy, Dudai & Karni, 2003; Shea, Lai, Black & Park, 2000).

### *1.3.2 To tell or not to tell: Instruction-free learning as an adjunct to error-reduction in perceptual motor skill learning for people with explicit memory impairments.*

Observation of participants in the touch-typing study and of others taught subsequently using the same methodology, suggested performance was disrupted when anything more than minimal verbal explanation was given by the instructor. It was therefore hypothesised that verbal instruction, which those with normal memory may find useful, could detrimentally affect skill acquisition in those with explicit memory deficits.

Explicit memory is primarily a verbal system and, in normal skill learning, works in concert with the type of 'learning by doing' mediated by implicit memory. Normal learning of motor skills is thought to proceed through the process of cognitive procedural learning (Beaunieux, Hubert, Witowski, Pitel, Rossi, Danion, Desgranges & Eustache, 2006) : that is, initially through verbally based explicit learning before passing on to an automated or implicit phase when the verbal rules are forgotten and processing becomes unconscious. It is suggested here that when explicit memory is compromised, repeatedly telling the learner what to do may act to overload verbal working memory (Maxwell et al., 2001; Poolton, Masters & Maxwell, 2005; Orrell, Eves & Masters, 2006) and/or promote a spurious reliance on defective explicit recall.

A search of the literature showed a small body of evidence suggesting that providing explicit instructions, at least during the early learning stages of a motor skill, may not be the optimal approach for both normal learners and some stroke patients (Boyd & Winstein, 2004; Boyd & Winstein, 2006; Orrell et al., 2006; Poolton et al., 2005; Wulf & Weigelt, 1997). This study tested the proposition that 'instruction free' learning when combined with error-reduced methodology, may further optimise skill acquisition in participants with explicit memory difficulties following brain injury by fostering implicit skill learning. Two groups of people were taught the perceptual motor-skill of golf putting, using an error-reduced paradigm devised and validated by Maxwell et al. (2001). One group was given verbal instructions on how to carry out the task between learning trials and the other told just to 'do their best.' Their performance was compared.

*1.3.3 It's not what you say, it's the way that you say it: Using conversational cues to enhance episodic recall of a Laurel and Hardy film clip in people with memory difficulties.*

Social isolation has been identified as the most common long-term psychosocial problem after brain injury and a major source of distress for both sufferers and their families (e.g. Kozloff, 1987; Morton, & Wehman, 1995; Weddell, Oddy & Jenkins, 1980; Hoofien, Gilboa, Vakil & Donovan, 2001; Verhaeghe, Defloor & Grypdonck, 2005). For example, over a third of those taking part in the Hoofien et al. study (2001) reported having no friends at all, and eight per cent were living in total isolation. Within families, also, a lack of meaningful social communication has been shown to be a significant source of stress, yet the availability of *any* intervention to aid this situation is rare (Boschen, Gargaro, Gan, Gerber & Brandys, 2007).

Many of our interactions with others involve the ability to tell coherent stories of our personal experiences which are recognised as important for a variety of social and psychological functions (Edwards, 1997; Norrick, 2000; Ochs & Capps, 2002). It is suggested in this work that one contributory factor to social isolation for those with acquired memory difficulty is their relative inability to recall the detail of their post injury experiences which hampers them from playing a satisfactory part in everyday conversations with friends and acquaintances. An intervention, therefore, which improves the ability to recall more detail of daily happenings, leading to more productive conversations, may contribute in a small way to ameliorating the problem of loneliness and loss of friends which is common in this population. At the time this study was embarked upon, however, no guidance was available on how this could be achieved.

This study employs for the first time an original approach to the enhancement of social recall using a dyadic technique described here as a 'cued conversation,' intended for use in ecologically valid conditions. The idea for the study originated from an observation by Wilson (1987) that people with memory impairment may remember more about what has happened to them depending on the way in which they are asked - in other words that some types of verbal exchange function as more effective recall cues than others. This led to a review of the literature on cueing studies in the laboratory (see section 2.3) which testify to the effectiveness of some types of cueing in those with normal and damaged memory under strictly controlled conditions. In order to explore the proposition that some types of verbal interaction act as better recall cues than others, this study focussed on identifying the characteristics of different types of questions and verbal exchanges used during a conversation about a recently experienced event, in this case the viewing of an eight minute film clip of the Laurel and Hardy comedy, *Way out West* (Laurel & Thorne, 1937). The resultant cueing capability of different types of conversational interactions (i.e. questions and other verbal prompts) was then evaluated in order to identify those which act as the most productive cues: whether, for example, open questions result in more items being recalled than closed questions, throughout a relatively long verbal interaction. This study appears to be unique in that it examines a memory enhancement technique



which must be learned and applied not by people with memory disabilities, but by the people who interact with them: the effort of learning the technique is in effect shifted to those most capable of acquiring it.

The study also examined for the first time, the effect, on participants with memory problems, of a recognised technique for boosting free recall in other populations - imaginal environmental context reinstatement (see Smith & Vela, 2001 for review) which involves encouraging participants to mentally reconstruct the external environment and internal thoughts and feelings about a witnessed event prior to free recall. The proposed effectiveness of environmental context reinstatement is predicated on the finding that recall is enhanced if the environmental context present at the original learning is reproduced at recall (Godden & Baddeley, 1975; Smith, Glenberg & Bjork, 1978; Smith, 1988) and provides an explanation for why revisiting a place can aid memory for what happened there, or why we fail to remember who someone is when he or she is encountered in an unfamiliar context (Smith & Vela, 2001).

#### **1.4 Publications arising from the thesis**

The touch typing study (Chapter Two) was published during the preparation of this thesis (Todd & Barrow, 2008). Since then it has been variously cited by authors researching ways to optimise the learning of skills by those with memory difficulty, ranging from the use of assistive technology to remembering daily routines (e.g. Ferland, Larente, Rowland & Davidson, 2013; Powell, Glang, Sohlberg & Albin, 2012; Ptak, Van der Linden & Schnider, 2010; Sohlberg, 2011; Sohlberg & Turkstra, 2011). It has been referred to as adding to the mounting evidence that with extensive training, even people with amnesia are capable of acquiring relatively flexible real world complex knowledge which shows some generalisation; that constraining errors in the acquisition phase of highly proceduralised tasks (2.3) is a key training variable for people with moderate to severe explicit memory deficits and that the meaningfulness and everyday usefulness of the task to the person is critical to success (Sohlberg, 2011). As was suggested in the touch typing study, Ptak et al. (2010) also concede that even subtle differences between tasks are important predictors of whether or not people with amnesia exhibit intact learning, underscoring the critical necessity for careful task analysis as a predictor of success.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Brain Injury and Memory Impairment – The Current Position

Each year in the UK an estimated 2,500 people join the list of those already living with the consequences of severe traumatic brain injury (Wilson, 2009) and most, if not all, will develop a memory problem (Goldstein & Levin, 1995). The diverse range of conditions affecting the brain means that accurate statistics are hard to come by, however memory problems can be experienced following brain haemorrhage, brain tumour, anoxia, mild traumatic brain injury and a range of neurological illnesses such as multiple sclerosis, and are present in an estimated seventy per cent of those who have suffered encephalitis and ten per cent of people with epilepsy (Wilson, 2009). The scale of the problem is growing as improved medical procedures result in better survival rates. Memory difficulties, ranging from mild forgetfulness to dense amnesia are among the most debilitating effects of brain injury and can seriously affect a person's ability to function (Glisky, Schacter & Tulving, 1986a). Yet despite being the most commonly complained of consequence of brain injury, most sufferers and their families get little or no professional help or guidance on memory management (Wilson, 1987, 2009), arguably as a result of a lack of people working in the field, and the time consuming nature of memory intervention training.

For people with memory difficulties and their families the picture can be a confusing one. On the one hand the prevailing opinion of many medical professionals is that, after a period of spontaneous recovery, little, if anything, can be done to restore lost memory function (Wilson, 2009), while at the same time the internet abounds with 'brain training' programmes which lead people to conclude that their memory can be improved with repetitive drills and games unrelated to their everyday lives; a strategy which in the past has shown very little generalisation to real world tasks (Ptak et al., 2010). However, this dispiriting picture is offset by developments in rehabilitation which demonstrate that, while currently memory cannot be restored, much can be done to compensate for everyday forgetfulness and learning difficulties by employing the types of strategies and instruction techniques described for example by (Wilson, 2009) and Sohlberg and Turkstra (2011) given, crucially, that the resources exist to disseminate that knowledge and facilitate the training.

Because of the presenting problems of people with memory difficulty, most memory rehabilitation aims to compensate for explicit memory deficits by teaching the use of 'external' memory aids such as the use of diaries or smart phones. For those with milder problems the use of rehearsal or mnemonics - known as 'internal' memory aids - is recommended. An example of this would be employing visual associations to remember people's names, as in Mr Fox has red hair, (e.g.

Thoene & Glisky, 1995) or a method, in which elements to be remembered are incorporated into a story (Crovitz, 1979, Wilson, 1987). With few exceptions, for example electronic reminder systems such as Neuropage© (Wilson, Evans, Emslie & Malinek, 1997; Wilson, Elmslie, Quirk, Evans & Watson, 2005) and arguably the ‘method of vanishing cues,’ (Glisky, Schacter & Tulving, 1986b), [See 2.3], memory techniques require an element of new explicit learning for how and when to use them. Efficient use of external memory aids involves motivation, planning, problem solving, concentration, learning and memory, all of which can be affected in brain injury so that the people who need to use them most have the most difficulty learning how to use them (Wilson, 2009). Also internal mnemonics have a limited usefulness, work best in people with mild memory impairment and crucially, generalisation - the extent to which the person uses the technique without prompting to do so in other areas of their life - is poor (Wilson, 1987). In either case, extensive practice is needed, preferably in the context where they are to be used, before the use of external aids, mnemonics or visualisation techniques become automatic, at which stage, presumably, implicit memory, which underlies the formation of habits, comes into play and the behaviour becomes routine. People with memory difficulties *can* learn, but there is no doubt that the process is time consuming and effortful and unless symptoms are mild, the learning tends to be highly specific and not to generalise to other tasks or transfer to everyday life (Glisky, 2005). It is suggested in this work that this is unsurprising and, perhaps, inevitable because damage to explicit memory impedes both the learning of ways to ameliorate memory deficits and their implementation. On the other hand it is contended that implicit learning, optimally employed, should require no more effort, time and labour than would be expended by a person with normal memory (Wilson, 2009). While not replacing traditional forms of memory training, implicit methods may prove a useful adjunct with two other major advantages: they are applicable to people with more severe memory problems and can avoid problems with transfer and generalisation.

## 2.2 Memory Research

In recent decades there has been an outpouring of research which has radically advanced the models of memory (Tulving, 2002). Whereas early modern theories envisaged memory as a two-stage system in which sensory information enters a short-term memory store before, if it is rehearsed adequately or processed at sufficient depth, being automatically passed on to long-term memory for permanent use (e.g. Atkinson & Shiffrin, 1968; Craik & Lockhart, 1972), current models, underpinned by advances in neuro-imaging, reveal the fractionation of memory into multiple complex systems or processes which interact dynamically, both in working memory which lasts for seconds or minutes (Baddeley, 2004) and long term memory for memories of longer duration (Schacter, Chiu & Ochsner, 1993; Squire, 2004; Tulving, 2002).

Short-term memory, formerly considered a relatively passive precursor to long term memory, has long been subsumed into a much wider general theory of working memory, which emphasises combined processing and storage (Baddeley & Hitch, 1974). In this model working memory is conceptualised as a limited capacity system which temporarily maintains, stores and manipulates information, acts as the interface between perception, long term memory and action and facilitates a range of cognitive functions (Baddeley, 1986; Baddeley, 2003). Working memory has been hypothesised as fractionated into sub-components or ‘slave systems’: the phonological loop, which deals with verbal information; its visual equivalent, the visuo-spatial sketchpad and most recently the episodic buffer (Baddeley, 2003) which allows information from the different slave systems to be integrated and linked to long term memory. These systems are envisaged as under the control of a component known as the central executive: “the most important but least understood” part of working memory (Baddeley, 2003 p.835) which guides their operation. Roughly equating to attention, the central executive builds on the concept of attentional control originally proposed by Norman & Shallice (1986) which postulates an attentionally limited supervisory activating system which comes into play when habit patterns or routines are insufficient to cope with novel experiences. Work on the central executive and other elements of working memory continues and looks set to identify still more components as research progresses. Baddeley (2003) has also called for more research into wider questions, such as the emotional and motivational control of working memory and a proposed link between working memory and consciousness.

Long-term memory, which refers to all memory of longer duration than a few seconds or minutes (Markowitsch, 2000; Squire & Zola, 1998), has come to be classified into major components with differing characteristics. The first is explicit memory, which refers to the abilities that the general public would consider to be the whole of memory, encompassing memory for events (episodic memory) and generic facts (semantic memory) which can be consciously brought to mind and expressed. The second major component of long-term memory is implicit memory, which does not require conscious recollection of the learning process to function and often cannot be verbalised. Implicit memory includes, among other attributes, procedural memory for motor skills and the phenomenon of priming, described as a higher likelihood of re-identifying stimuli perceived at a previous point in time (Tulving & Markowitsch, 1998).

Episodic memory, which requires self-conscious reflection, is the most complex memory system (Markowitsch, 2000). It is distinguished by its time travel effect - the ability to re-experience a specific event (Tulving, 1983, 2002). Semantic memory, on the other hand, is context-free memory for facts, for example the meaning of the word ‘bottle’ or that the sun is hot which can be used across a wide variety of situations (Shimamura & Squire, 1987; Tulving, 1989; Wilson & Baddeley 1988).

It has been known for decades that people with amnesia retain certain unconscious memory and learning abilities, stretching back to the classic work with the amnesic patient Henry Molaison (e.g. Milner, 1962; Milner, 1966; Milner, Corkin, & Teuber, 1968; Milner, 2005) and modern research into implicit memory arose from studies of people with brain injury which showed sharp dissociations

between explicit and implicit memory tasks, or “unaware representations of retention,” (Roediger, 1990, p.1045). Experimentally, explicit and implicit memory are classified according to performance on different types of memory tasks (Graf & Schacter, 1985; Schacter 1987; Schacter et al., 1993). Explicit memory requires conscious recollection or recognition, for example of items on a previously studied list. The participant is required to recall the learning episode in order to express what has been experienced. In contrast, implicit memory is memory without awareness (Jacoby & Witherspoon, 1982) - characterised by an unintentional and unconscious change in recall or skill performance based on prior exposure and there is no requirement for the person performing the task to consciously recall the occurrence of prior study or skill learning. In the laboratory re-presenting word-fragment completion tests, mirror reading and pursuit rotor tasks in which participants are required to track a target by moving the position of a pointer, are commonly used to assess the effects of prior presentation and thus test implicit memory performance (Schacter et al., 1993). While there is still much to learn there can be no dispute that theoretical questions about the processes involved in implicit learning have been pursued with rigour. For example, Roediger (1990), has posited that just one component of implicit memory - priming- consists of three separate components, adding that dissociations observed by those investigating amnesia indicated up to 25 different memory systems might be implicated in priming alone while “the number of dissociations between tests is likely to increase inexorably” (Roediger, 1990, p.1053).

While showing deficits in explicit recall and recognition, people with amnesia have been shown to be able to perform normally or near normally on implicit laboratory tasks of motor-skills (e.g. Brooks & Baddeley, 1976; Cohen, 1984; Cohen & Squire, 1980; Corkin, 1968; Gauggel & Fishcher, 2001; Milner et al., 1968; Starr & Phillips; 1970) and priming tasks, such as word fragment completion (e.g. Tulving, Schacter & Stark, 1982; Tulving & Schacter, 1990; Warrington & Weiskrantz, 1974); pattern analysis (Cohen & Squire, 1980); picture naming (e.g. Biederman, Gerhardstein & Cooper, 1997) and picture fragment completion (e.g. Shum, Jamieson, Bahr & Wallace, 1999; Warrington & Weiskrantz, 1974). However, priming of words from word lists, using word stems as cues, was found to require certain conditions to operate successfully in people with amnesia (Tulving & Schacter, 1990), depending crucially on the type of instructions given to the participants. When told to remember the correct word from a previously studied list, they showed poorer recall than normal controls. However when asked to respond with ‘the first word that comes to mind,’ they showed normal recall (Graf, Squire & Mandler, 1984) and did not realise they were remembering but rather assumed a correct response to a cue was just a lucky guess (Hamann, Squire & Schacter, 1995). The critical feature of the test instructions appears to be therefore that participants are *not* told the tests measure recall of recent experiences, just to perform as well as possible, for example by guessing words from impoverished cues (Roediger, 1990). The studies cited above all involve visual presentation of material. However, significant priming effects have also been demonstrated when information is presented either in an

auditory or visual modality and (though the effect was smaller) when tested across these modalities (Graf, Shimamura, & Squire, 1985). In addition to tests of implicit memory based on perceptual information, people with amnesia have demonstrated priming on conceptual tasks which involve naming “the first eight exemplars that came to mind,” (Graf et al. 1985, p. 391) from a previously studied list when a category was given as a cue, for example ‘bird’. The fact that people with amnesia perform normally on such tasks when they are structured appropriately demonstrates that priming is a distinct form of memory, separate from other functions that are impaired in amnesia (Schacter & Buckner, 1998; Tulving & Shachter, 1990; Squire, 2004).

Prior to the dissociations between implicit and explicit memory tasks in people with organic amnesia, which began to emerge in the middle of the last century, cognitive psychologists interested in learning and memory focused on explicit recall and recognition tests in their work and theories of memory were based on these results, (Gabrieli, Fleischman, Keane, Reminger & Morrell, 1995). The apparent late discovery of the power of priming is explained by the fact that it is non-conscious and it is “difficult to study a phenomenon whose existence one does not suspect” (Tulving & Schacter, 1990 p.302). However, priming is now considered a ubiquitous phenomenon, performing a more important role in everyday life than was previously assumed and it is acknowledged that although priming is typically observed under carefully controlled conditions in the laboratory, similar conditions frequently occur naturally, in the outside world (Tulving & Schacter, 1990)

However memory deficits seldom map one to one onto memory tasks because few memory deficits, if any, involve a single memory system (Tulving, 2002). There is good evidence that all cognitive systems are supported by intricately interconnected brain regions of “almost infinite richness and flexibility” (Mesulam 1990, p. 597) and that the same brain regions can be activated in response to different cognitive demands (Cabeza & Nyberg, 2000), therefore the probability of the kind of brain damage that applies solely to one memory system and spares another in such a complex system is small. Most of the time the damage affects the components or connections between multiple systems, resulting in the typical diffuse impairment of memory for facts and events which results in disability for people with memory impairments (Squire, 1992). Also recent evidence has emerged on the interaction between implicit and explicit memory which has shifted the focus of some research away from isolating one type of memory from another to studying their interaction (Moscovitch, 2008). Investigators looking to establish the independence of implicit memory have traditionally used tasks which ensured implicit task performance was not contaminated by explicit processes (Roediger & McDermott, 1993). However more recently Sheldon and Moscovitch (2010) have shown experimentally that in normal memory, recollection, a function of explicit memory also benefits implicitly mediated priming. This is consistent with Moscovich’s (2008) proposal that explicit recollection is a two-stage process, one rapid and unconscious (consistent with priming) and the other more effortful and conscious (consistent with explicit memory). Similarly, Tulving and Schacter (1990) conceptualise an interactive two component

process: priming represents a pre-semantic perceptual representation system (PRS) which exists separately but interacts closely with other memory systems. The PRS is concerned with identification of perceptual objects, including words, and is not critically dependent on the brain regions necessary for semantic and episodic memory.

People with amnesia and less severe memory problems can suffer variable amounts of retrograde amnesia i.e. difficulty recalling facts and events prior to pathology. However, for the vast majority their greatest handicap is anterograde amnesia: difficulty in forming or accessing new explicit memories: both episodic memories for events that have occurred since injury (e.g. Baddeley & Wilson, 1986; Wilson & Baddeley, 1988; Wilson, 2009) and semantic memories, for facts and terms about the world (Gabrieli, Cohen, & Corkin, 1988) though there is evidence that in some rare cases, anterograde semantic memory can remain selectively intact (Baddeley, Vargha-Khadem & Mishkin, 2001; Vargha-Khadem, Gadian & Mishkin, 2002).

The classic view of episodic memory is that it contains knowledge of events and facts acquired in the recent past or over the lifespan, though some researchers propose a separate autobiographical memory system which is “the knowledge base of the self,” (Conway, 2002, p.56) constituting a longer term accumulation of episodic memories and semantic knowledge. Whichever view is taken, the greatest handicap for people with memory impairments remains a difficulty making new explicit memories for the time since their injury (Wilson, 2009) and the remediation of episodic and semantic memory therefore has been the main focus of rehabilitation. On the other hand most people with amnesia perform normally or near normally on implicit tasks including priming and motor skill learning. However their abilities in these areas have been difficult to apply to the everyday problems of people with memory difficulties (Wilson, 2009) and remain a widely neglected and untapped resource (Cavaco, Malec & Berquist, 2005).

### **2.3 Memory rehabilitation research**

Against the background of extensive research into memory, outlined above, several promising approaches to practical memory rehabilitation have been developed in the last thirty years which have as their basis experimental studies involving people with memory-impairments and those with normal memory. Specifically studies of impaired and unimpaired memory functions in people with amnesia have strongly contributed to the distinction between explicit and implicit memory systems, with numerous studies demonstrating the relatively preserved procedural learning abilities of people with amnesia (Ptak et al, 2010). Nowadays, many rehabilitation techniques rely, to a greater or lesser extent, on implicit memory, and because of this some are applicable even to those with dense amnesia (Ptak et al, 2010). The contention in this thesis is that the discovery of the integrity of implicit memory and experimental work demonstrating its contribution both to learning and recall are the most important theoretical contributions to memory rehabilitation research to date. For the future, emerging work on

the interconnectedness and dynamic interactions between the implicit and explicit memory systems may prove valuable in that it may eventually produce novel approaches into ways in which both memory systems can be optimised.

Historically there have been various opinions about what constitutes memory rehabilitation. Some see restoration or improvement in overall memory function as the goal, using improvements in post treatment test scores as a measure of success, while others look to train people with memory problems to use aids to compensate for their deficits with the goal of improving everyday functioning (Rohling, Faust, Beverly & Demakis, 2009). The first approach focuses on restitution, or at least amelioration, of lost function by capitalising on neural plasticity. The assumption is that cognitive processes which have been partially damaged can be directly re-trained by fostering reconnection or reorganisation of damaged neural circuits through exposure and practice (Robertson, & Murre, 1999). The second approach emphasises interventions involving the learning of specific strategies which can be used in everyday life to compensate for chronic defects (Rohling et al, 2009). There is some evidence of effectiveness for stimulation-based treatments in the rehabilitation of brain injury-induced deficits such as hemiplegia, aphasia and attention (Robertson, & Murre, 1999) and the possibility cannot be completely ruled out that in future ways may be found to stimulate damaged memory circuits, especially in the light of findings indicating that the normal brain may be more susceptible to local plasticity than was previously thought (Ogden, 2000; Maguire, Gadian, Johnsrude, Good, Ashburner, Frackowiak & Frith, 2000). However, currently, episodic memory is viewed as a special case among cognitive functions, for which only compensatory strategies such as structure, external cueing, and use of memory aids and mnemonics are appropriate (Robertson, & Murre, 1999; Wilson, 1998). Indeed, past attempts to restore memory which obliged the trainee to spend hours practising computer-based exercises in order to remember random words, and objects (Glisky, 2005) have singularly failed to provide any general benefit to overall memory function (Benedict, Brandt, & Bergey, 1993; Berg, Koning-Haanstra & Deelman, 1991; Godfrey & Knight, 1985). However, this approach did reinforce the idea that people with memory problems do get better at the *specific tasks* they practice. Therefore it makes sense that they should spend time practising useful skills which they want to learn (Glisky, 2005) and, also, though it may take many hours to achieve and in most cases does not generalise, acquisition of specific knowledge pertaining to the person's everyday life is possible under the right conditions (Glisky, 2005).

While it is no longer in doubt that people with memory impairment retain implicit memory abilities, in reality they tend not to spontaneously take advantage of their capacity for skill learning (though there are exceptions, for example, Winter's, (2002), descriptive study of a young man with memory problems who became expert at the computer game of Tetris and Wilson's (2003) anecdotal account of a self-taught typist). In rehabilitation researchers have long raised the issue of how spared capabilities can be harnessed to alleviate some of the quotidian problems of people with memory



disorders (Glisky et al, 1986a) and two important teaching techniques have emerged in recent years to aid some types of learning in people with memory problems, both of which aim to capitalise on preserved implicit memory to teach skills or facts. The first is error-free, or errorless learning, in which the person receiving instruction is prevented as far as possible from making mistakes, (e.g. Wilson, Baddeley, Evans, & Sheil, 1994; Hunkin, Squires, Aldrich, & Parkin 1998; Evans et al., 2000). According to Wilson (2009) people with amnesia cannot use explicit memory, so they are forced to rely on intact implicit memory, which by itself cannot discriminate mistakes. It has also been argued that in others with less severe memory problems, reliance on faulty explicit memory means they are unable to recall their errors and so cannot correct their prior mistakes efficiently (Baddeley & Wilson, 1994). The fact that mistakes are being made reinforces the faulty response, so the ideal is to prevent errors being made in the first place. This can be done through appropriate approaches to a wide range of tasks involving the use of manipulations to avoid errors, such as guiding the person through the task, providing spoken or written instructions or modelling the steps of a procedure little by little (Wilson, 2009). For example, combined with high rates of practice, error free learning has been successfully employed in teaching a seven-step e-mail task using a computerised instruction package (Ehlhardt, Sohlberg, Glang, & Albin, 2005) and in teaching two people with amnesia and executive problems complex semantic information about their therapists and how to programme an electronic organiser (Beaunieux et al., 2006) and touch typing (Todd & Barrow, 2008). Other studies where error-free learning has been employed, have reported significant difference in people with amnesia learning word lists, new items of general knowledge, how to programme an electronic device and remembering orientation landmarks under error-free conditions (Wilson, *et al*, 1994). Whether error-free learning succeeds through implicit processes (Baddeley & Wilson, 1994; Wilson, Sheil, Carter and Norris, 2006), through residual explicit memory (Hunkin, Squires, Aldrich & Parkin, 1998), or through a combination of both (Kessels, Boekhorst & Postma, 2005) remains in dispute. However, the fact that error-free learning ‘works’ in many cases for people with amnesia, and that those taught in this way do not necessarily recall the source of their learning, supports the contention that it operates through implicit memory (Page, et al., 2006). While theoretically interesting, the actual mechanisms behind the advantage conferred by error-free learning in rehabilitation is moot. In real life, cases of pure amnesia, in which no explicit memory is available, are extremely rare and most candidates for error-free instruction retain variable amounts of explicit memory. Therefore in practical terms whether error-free learning acts differentially through either or both retained implicit and residual explicit memory, the underlying assumption remains valid: a principal reason why learning is problematic for people with memory difficulties is the loss of the spontaneous ability to correct errors during the learning process and this tendency is addressed substantially if the learner is taught without interference from previous errors. The impact of errors on learning appears to depend on the particular task involved (Evans et al., 2000). However, there is mounting evidence that error-reduction is a key variable in the acquisition of

highly proceduralised tasks for people with moderate to severe explicit memory impairments (Sohlberg & Turkstra, 2011), such as route recall (Lloyd, Riley & Powell, 2009) and individualised memory interventions (Campbell, Wilson, McCann, Kernahan & Rogers, 2007). In particular, during the acquisition of motor-skills by those with normal memory, error reduction appears to confer advantages over practice in which mistakes are made by rendering the skill robust in the face of interference (Maxwell et al., 2008).

Another learning aid, the method of ‘vanishing cues’ to teach vocabulary (e.g. Glisky et al., 1986a, 1986b) is aimed at capitalising on preserved implicit memory, specifically the ability of people with amnesia to respond to the priming of words in stem completion tasks, as demonstrated in research on direct priming (Cermak, Talbot, Chandler & Woolbarst, 1985; Diamond & Rozin, 1984; Graf Mandler, 1984; Graf & Schacter, 1985; Schacter, 1985; Warrington & Weiskrantz, 1974). Probably the earliest attempts to use priming coupled with practice as a rehabilitation tool outside the laboratory were employed by Glisky et al. (1986a, 1986b) in two studies using the method of vanishing cues to teach people with memory impairments computer related vocabulary necessary for them to programme an early computer. The method of vanishing cues involves the learner being cued with as many letters as required to elicit a correct target word. Letters are then withdrawn across learning trials until the participant can produce the word in the absence of letter cues. Researchers in the Glisky et al. (1986a) study found that computer related words were learned and retained after six weeks and that the method was more efficient than repetition. The notion that this learning was achieved by implicit means is given credence by the fact that the participants did not recall learning the words they later generated. In the second study (Glisky 1986b) participants learned more complex computer instructions using a system of computer-generated ‘hints,’ to achieve correct responses. All participants with memory impairment showed great improvement by the end of training and substantial retention. However they took many more trials than controls over days of practice and repetition (Glisky et al., 1986b). Controls were also less variable in their performance and rarely regressed during a session compared with the memory-impaired group. One outstanding finding was that the knowledge gained by those with memory impairments was qualitatively different from those with typical memory. It was “hyper specific,” i.e. relatively inflexible, rigidly organised and only narrowly accessible, being only available if the cue was presented in a precisely consistent form (Glisky et al., 1986b p.325). Despite these qualifications, knowledge gained in this way can be useful in real life. In a later study using vanishing cues, a woman with amnesia was taught 250 computer related pieces of information, allowing her to perform a real world data entry job as efficiently as her work colleagues (Glisky & Schacter, 1989). Error-free learning has broader parameters for application than Glisky’s cueing system. It can be applied across a variety of circumstances, whereas the method of vanishing cues is used primarily as a means of teaching semantic information. This is reflected in a meta-analysis of error free and vanishing

cues learning (Kessels & Haan, 2003) which found a significant effect size for error free learning and a small non-significant effect for vanishing cues

More recently the advantage of error-free learning in the acquisition of certain tasks has been questioned on the basis that it conflicts with key findings from non-clinical populations, stretching back over a century, that effortful retrieval from long term memory bolsters the likelihood of successful remembering in the future and that retrieval failure (i.e. making mistakes) can actually lead to deeper encoding of target information (Middleton & Schwartz, 2012). It is a well-accepted principle in research on normal learning and memory that retrieving information from long term memory (retrieval practice) is a “learning event in its own right” (Middleton & Schwartz, 2012 p.139). However, retrieval practice has also been found to be effective in the first published study of people with neurologically based memory difficulty, using 16 participants with multiple sclerosis (Sumowski, Chiarvalloti & DeLuca, 2010), demonstrating a strong advantage of retrieval practice through re-testing over restudying the material to be remembered. In normal memory the testing effect - referring to the recall advantage gained when material is tested over that which is presented for additional study - has been found to be productive in long-term retention of paired associates (Allen, Mahler & Estes, 1969; Kuo & Hirshman, 1996). Normal memory appears to be enhanced by the ‘spacing effect,’ i.e. with spaced repetition of the information to be learned over a period of time being more effective than massed practice (Dempster, 1996), and spacing is also included as a part of a package of advised instruction techniques for people with memory problems along with error reduction (Elhardt, Sohlberg, Kennedy, Coelho, Ylvisaker, Turkstra & Yorkston, 2008). Normal memory appears to be most enhanced when the two techniques of testing and spacing, are used in combination (Carpenter & DeLosh, 2005), however this does not appear to have been investigated in people with brain injury.

In explanation for the enhanced learning effect of testing, Middleton and Schwartz (2012) hypothesise that retrieval is the most important factor in achieving robust learning. Further, they suggest that the testing effect is likely to arise because of two factors: retrieving information from long term memory changes memory in a way that bolsters the likelihood of successful future retrieval and that initial failure to retrieve information leads to deeper encoding which can subsequently be used as feedback, compared to a situation where no test is provided. The proposal that memory is in fact boosted by deeper encoding, ensuing from initial failure to retrieve information, appears to contradict the very basis of error-free learning which, by preventing mistakes, precludes these initial abortive attempts at remembering. It is proposed here that the difference lies in the distinction between tasks. Error free learning is effective when *learning and teaching* new tasks, particularly motor skills and highly proceduralised tasks. In contrast, effortful retrieval, it is suggested here, may enhance to some extent the spontaneous episodic *recall* necessary for remembering recent events, especially if used as a follow-up stage to priming. This is consistent with Moscovich’s (2008) proposal that explicit recollection is at least a two-stage process, one rapid and unconscious (consistent with priming) whose

output can contribute to performance on a variety of tasks including those that are implicit and semantic. The other is slower, more effortful and is one in which the individual becomes consciously aware of this output and can make it explicit (Moscovich, 2008).

#### **2.4 Objectives of the thesis**

The studies described in this thesis attempt to optimise some of the findings from the vast body of memory research, highlighted above, in novel ways which are of use to people with memory impairments in their everyday lives, focusing on the robust evidence of their preserved implicit memory abilities which have proved difficult to apply to the real life problems encountered by people with memory difficulties (Wilson, 2009).

## CHAPTER THREE

### **3.1 Teaching memory - impaired people to touch type: The acquisition of a useful complex perceptual - motor skill.**

#### INTRODUCTION

The proposition under scrutiny in this paper was whether or not people with memory impairment are capable of learning the complex perceptual-motor skill of touch typing to a useful level: in other words whether the observations of preserved abilities in perceptual motor skill learning using simple laboratory tasks (e.g. Brooks & Baddeley, 1976; Cohen, 1984; Cohen & Squire, 1980; Corkin, 1968; Gauggel & Fishcher, 2001; Starr & Phillips, 1970) apply to learning a real-world perceptual-motor skill, and crucially whether the skill is retained over time thus proving robust and resistant to deterioration, in contrast to some other forms of implicit learning (Evans et al., 2000). Touch typing could be especially useful to people with memory impairment, since it provides a sound basis for learning to use computers which, in addition to being ubiquitous at work and at home, have long been recognised as having great potential as compensatory memory aids (Hunkin et al., 1998). Since decreased capacity for learning is extremely detrimental to the aspirations of memory-impaired people, an exception, provided by their ability to acquire functional motor skills, could have the potential to improve their everyday lives and job prospects. The aim of this study was to capitalise on the reported preserved abilities in motor skill learning to teach two people with memory impairments to touch type, on the basis that touch typing, while complex, is a perceptual - motor skill that theoretically could be acquired by people with preserved procedural memory, especially if they are taught in ways which maximise acquisition.

Memory difficulties are among the most commonly reported cognitive problems following brain injury (Wilson, 2003). People with memory impairment suffer learning difficulties in areas which involve the acquisition of either semantic knowledge, recall of recent events, or both; yet they are credited repeatedly in the literature with the ability to acquire new perceptual-motor skills, even though they may not remember when or how they learned to perform them. This is considered to be because procedural memory which mediates the learning of skills, such as riding a bike or playing a musical instrument, is relatively preserved or nearly normal in people with memory difficulties, compared with learning via explicit memory which involves the conscious recall of facts and is more susceptible to

impairment (Brooks & Baddeley, 1976; Cohen & Squire, 1980; Corkin, 1968; Gupta & Cohen, 2002; Van der Linden & Coyette, 1995; Wilson, 2003). However, although all implicit memory functions are considered to show relative preservation in amnesia, there is evidence that these functions may not be unitary and may be manifestations of different implicit systems (Evans et al., 2000).

Motor skills are the most concrete examples of procedural learning (Anderson, 1983) and are thought to be acquired through implicit memory, which also mediates other types of largely non-conscious learning such as classical conditioning and verbal and visual priming. Maxwell et al. (2001) note that acquisition of perceptual - motor skills does not require the same level of cognitive resources as the acquisition of skills involving elements of decision making and problem solving - the types of skills which are conceptualized for example by models such as the Adaptive Control of Thought (ACT) theory (Anderson, 1983), S-mode learning (Berry & Broadbent, 1984, 1988) and the initial phases of the process of cognitive procedural learning (Beaunieux et al., 2006). However, traditionally, motor skills have been considered to be acquired in a similar manner to that of cognitive procedural learning: that is, initially through verbally based explicit learning before passing on to an automated or implicit phase when the verbal rules are forgotten and processing becomes unconscious. The performer was assumed to learn through making judgements about how to perform the task - hypothesis testing - intuitively referring back to prior errors so that they would not be repeated (Anderson, 1983). More recent research challenges the assumption that motor skill learning must necessarily proceed from the explicit to the implicit. Evidence is emerging that motor skills need not rely on input from explicit memory; that employing learning strategies which actively minimise the accrual of explicit knowledge may benefit motor skill learning and that it is possible for learning to be achieved through relatively passive aggregation of action-outcome contingencies gained through simple exposure (Maxwell et al., 2001; Poolton et al., 2005; Orrell et al., 2006).

The support for the claim that people with memory difficulties can learn perceptual-motor skills is either anecdotal or based on laboratory tasks using relatively easy and quickly-learned tasks such as manual tracking and finger tapping (Corkin, 1968); finger mazes (Starr & Phillips, 1970); pursuit rotor tasks (Brooks & Baddeley, 1976); reading reversed writing (Cohen & Squire, 1980); mirror drawing (Cohen, 1984) and pegboards (Gauggel & Fishcher, 2001). People with memory impairment have also been taught to use a computer keyboard, but where this has been done the motor skill aspect of typing has been either: restricted to a small set of words or paragraph (Glisky et al., 1986a; Hunkin et al., 1998); achieved very slowly as an adjunct to learning other computer functions (Van der Linden & Coyette, 1995), or was a retained skill from prior to brain injury (Glisky & Shacter, 1987).

Limited attempts have been made to use skill learning in clinical settings but currently the resource remains largely untapped (Cavaco, et al., 2005) and according to Wilson (2003), efforts to help people build on their preserved memory abilities have, up to now, proved disappointing. There are

few reported studies in which people with memory impairments have learned new, useful or complex motor skills which are applicable to their everyday lives, and none in which they have been taught to touch type. Winter (2002) gives an account of a young man who became expert at the computer game of Tetris and Wilson (2003) refers anecdotally to a young man with amnesia who taught himself to type, but the manner in which these tasks were acquired was not investigated.

The performance of skilled touch typists using manual typewriters has been thoroughly investigated by psychologists interested in the acquisition of automatic skills which remain resistant to interference under dual task conditions (Salthouse, 1986). Nowadays the QWERTY keyboard remains the main interface between computer and user and its efficient use is considered a primary ability in the hierarchy of computer skills (Johnson, 1992). Yet touch typing, which results in high speed, accurate use of the keyboard, is not routinely taught. Most novice computer users gain facility with the keyboard by 'picking it up as they go along,' through a strategy aptly described as 'hunt and peck,' an *ad hoc* method of learning to type which involves visually searching the keyboard for the letter to be typed and striking it with any finger. It is argued here that this improvised strategy may be problematic for people with memory impairment because: it requires input from episodic memory to recall the position of the key from one session to another at least in the early stages of learning; it makes demands on working memory as the learner must hold the word to be typed in mind while executing a complex process (remember the word to be typed, scan the keyboard for the next key, locate the key, strike the key, look back at the screen etc.) and finally it renders the learner vulnerable to making mistakes, while ideally people are thought to learn some tasks best under conditions where mistakes are kept to a minimum (Evans et al., 2000; Hunkin et al., 1998; Wilson et al., 1994). A principal reason why learning is problematic for memory-impaired people is assumed to be the loss of the spontaneous ability to correct errors while learning. Baddeley and Wilson (1994) suggest that explicit learners can look back and correct errors they made previously, whereas implicit learners cannot, and so repeat their prior mistakes. This tendency is addressed to some extent if the learner is taught under errorless conditions where mistakes are reduced or eliminated during learning. However the impact of errors may depend on the particular task involved (Evans et al., 2000).

As far as perceptual-motor skills are concerned, the argument for using errorless techniques is compelling, for example, errorless teaching of golf putting to normal learners led to fewer errors in learning, superior retention and more robust performance in the face of additional cognitive load than for the errorful learning group (Maxwell et al., 2001; Poolton, et al., 2005), giving better performance under stress. These researchers argue that the technique of reducing errors functions to effectively suppress the use of working and explicit memory in normal learners during the initial stages of learning by preventing hypothesis testing and the tendency to look back to prior errors. Their findings suggest that explicit memory functions are not requisite, and indeed may hamper, the acquisition and robust retention of a complex perceptual - motor skill. So touch typing may present an optimal task for those

with memory impairment because here typing is acquired in a manner which lends itself to efficient motor skill learning: facility is acquired in a structured manner through the repetition of sequences of actions which become automatised through extensive practice (Anderson, 1983).

In touch typing the typist is trained *not* to visually scan the keyboard; instead each of the eight fingers is schooled to execute the correct 'finger reach' for a specific key by touch while the typist focusses either on the material to be copied, or on the screen. In this way the learner builds 'finger memory' for the keys which equates to the motor component of skilled performance on a musical instrument and is defined as an acquired, unconscious bias in human movement which transpires in sequence learning and in motor skills, allowing faster movements in response to a target (Keisler & Willingham, 2007). So touch-typing training may be apposite for those with impaired memory because as an exact skill, in which the typist must use the correct finger reach to get the correct result, it lends itself to an errorless style of instruction in which the learner can be verbally or physically prompted to use the correct keystroke. It is important in the rehabilitation of amnesia that consideration is given to the task to be learned; some procedural tasks involve cognitive input from working and episodic memory in the primary and intermediate stages of learning, so that people are prevented from reaching the final autonomous stage which is when the task becomes purely procedural, a reason postulated for their failure (Beaunieux et al., 2006).

It was recognised that learning to touch type to a level of automaticity, as with other complex motor skills, could take weeks or months of patient, deliberate practice to achieve (Bower, 2000). Since lessons for the participants in this study were voluntary and were carried out in a non - clinical setting and over an extended period of time, the outcome depended on the commitment of the learners. Therefore attempts were made to provide participants with the best chance of success in order to boost motivation and encourage continued attendance at learning sessions. This was done, in the context of a number of practical constraints, by attempting to create optimal conditions for learning, based on current empirical evidence. Learning conditions therefore included individual coaching, errorless techniques, standardised repetitions of sessions, saturation of learning and distributed - rather than massed - practice (the rationale and evidence for introducing these conditions is described below in the Method section). No attempt was made to investigate the relative contribution of these conditions to skill acquisition. The performance of two participants, one with severely impaired memory and one with moderately impaired memory, was compared with that of two normal learners throughout the training on dimensions of acquisition, consolidation and transfer, speed and accuracy and retention to evaluate their progress.

The hypothesis under investigation was that due to their relatively preserved implicit memory and given the conditions for learning referred to above, the two participants with memory impairments should be able to acquire the complex perceptual motor skill of touch typing to level comparable with the comparison participants with normal memory.



## METHOD

### Design

A quasi - experimental design in which two participants with memory impairment were compared with two normal learners training to touch type was adopted which took into consideration the nature of the task (Foster & Parker, 1995), the extended period of time necessary to complete the training, and the naturalistic conditions in which the study was carried out. At key points throughout the training, data, in the form of the number of sessions taken by each participant to reach predetermined criterion levels and scores on speed and accuracy trials were collected by the researcher. Retention levels one year later were also assessed. The study planned a final criterion of 20 wpm with over 90% accuracy as a yardstick of functional typing ability, however, the participants were keen to continue beyond this level, and consequently the results of this extended practice are reported as they may provide useful data on the capacity for skill learning in this group of people.

In order to optimise skill acquisition a number of learning principles were employed based on empirical evidence.

*Distributed practice.* There is ample evidence that distributed practice benefits motor skill learning in normal learners. Spacing training sessions across days has been shown to be effective across a number of tasks: typing skills (Baddeley & Longman, 1978), balancing and key pressing tasks (Shea et al., 2000), digital piano keyboard sequences (Duke & Davis, 2006), mirror - reading (Ofen - Noy et al., 2003). Performance enhancements between spaced sessions, indicating that learning continued after the cessation of practice sessions (which may be attributable to memory consolidation during sleep) have been observed in simple and complex motor skills spaced across days (Duke & Davis 2006; Fischer, Hallsmid, Elsner & Born, 2002; Hauptmann et al., 2005) unlike cognitive procedural skills where distributed practice, separated by 24 hours was shown to hamper the transition to the automatic phase in the learning process (Beaunieux et al., 2006).

*Saturation of learning.* Gains in performance appear to occur in spaced learning, without additional practice (Hauptmann et al., 2005). Investigating the conditions necessary for triggering the delayed gains phenomenon, Hauptmann et al. (2005) concluded that the levelling off of performance in a within session trial is predictive of this effect and the amount needed will obviously vary from person to person.

*Standardised repetitions of sessions.* Reducing variability or promoting consistency of practice has been shown to promote automisation (Wickens, 1989). In this study structure and consistency across

training sessions was facilitated by the use of a CD-ROM instructional package. A good case can be made for using this type of computer package for those who need repetitious learning because the software provides the same practice situation over long periods of use.

*Individual coaching.* Individual coaching, has been shown to be effective in computer training with people who had brain injury (Clegg & Rowe, 1996), while physically guided practice has been found to be superior in motor skill learning to non-guided practice (Maxwell et al., 2001), perhaps because it allows the learner to experience the target movement at an earlier stage in learning than would normally be the case (Wulf et al., 1998). The role of the coach included providing errorless teaching in the form of verbal or physical prompts, cues and corrections to the learner.

### **Materials and Apparatus**

Each participant was provided with a personal CD-ROM of the "KAZ" Keyboard A - Z Learn *to touch type in just 90 minutes* for Microsoft Windows and Macintosh (Gotham New Media, 2001). The system is designed to teach the keyboard to people with normal memory. The software provides the option of being run using computer generated spoken instructions or a text - only version where written instructions appear on screen. In this study the software was run using the text - only version, on a Microsoft PC using Windows 98. An off - the - peg CD - ROM training package was chosen, rather than an instruction manual or classroom approach because it is cheap and needs no adaptations however, one drawback is that the software can be difficult to follow for people with brain injuries because it requires the learner to draw on additional attention and memory functions to navigate the package and follow on - screen instructions (Clegg & Rowe, 1996). This is obviated if the learner has support from a coach to navigate the software on the learner's behalf and explain the on - screen instructions.

### **Participants**

Participants were recruited from a centre for people with brain injury run by the Brain and Spinal Injury Centre (BASIC). Two participants with memory impairments (LH & CJ) and two comparison participants with no memory impairments, connected with the charity (TT & IR) came forward in response to a poster offering touch typing lessons. All four participants left formal education at the age of 16. Their psychometric details are reported at Table 3.1 below.

Table 3.1: Psychometric Details of Participants

|                    |                                 | LH                      |       | CJ                    |       |
|--------------------|---------------------------------|-------------------------|-------|-----------------------|-------|
| WAIS- III          | Full Scale IQ                   | 90                      |       | 82                    |       |
|                    | Verbal IQ                       | 89                      |       | 82                    |       |
|                    | Performance IQ                  | 94                      |       | 85                    |       |
| WMS Subtests       | Verbal Comprehension            | 84                      |       | 82                    |       |
|                    | Perceptual Organisation         | 99                      |       | 91                    |       |
|                    | Working Memory                  | 97                      |       | 86                    |       |
|                    | Processing speed                | 86                      |       | 93                    |       |
| NART               | Estimated Full Scale IQ         | 94                      |       | 92                    |       |
|                    | Estimated Verbal IQ             | 92                      |       | 90                    |       |
|                    | Estimated Performance IQ        | 98                      |       | 97                    |       |
| RBMT               | Screening score                 | 5 (Moderately Impaired) |       | 2 (Severely Impaired) |       |
|                    | Profile score                   | 17 (Poor Memory)        |       | 9 (Severely Impaired) |       |
| Camden Memory Test |                                 | % ile                   |       | % ile                 |       |
|                    | Words                           | Below chance            |       | <5                    |       |
|                    | Faces                           | Below chance            |       | <5                    |       |
| Rey Figure         |                                 | Score                   | % ile | Score                 | % ile |
|                    | Copy                            | 31                      | <1    | 27                    | <1    |
|                    | Immediate                       | 13.5                    | 2     | 5.5                   | <1    |
|                    | Delayed                         | 14                      | 2     | 4                     | <1    |
| Stroop             |                                 | Score                   | % ile | Score                 | % ile |
|                    | Colour                          | 112                     | 100   | 112                   | 100   |
|                    | Colour/word                     | 84                      | 5-6   | 85                    | 24    |
| TEA                |                                 | Score                   | % ile | Score                 | % ile |
|                    | Visual elevator (accuracy)      | 10                      | 75    | 9                     | 50    |
|                    | Visual elevator (speed)         | 3.9                     | 25-50 | 4.1                   | 50    |
|                    | Elevator count with distraction | 4                       | 10    | 7                     | 10-25 |

*CJ.*

CJ is a 55 - years - old woman who underwent left temporal lobe surgery for severe epilepsy six months before the start of this study, which resulted in a deterioration of her memory. CJ suffered frequent epileptic seizures since her early teens, which disrupted her education. She has never had paid employment, but has run a home and cared for two children. Post - operatively, her WAIS Full Scale IQ (Wechsler, 1997) was in the 'low average' range. Her memory assessed using the RBMT (Wilson, Cockburn & Baddeley, 1991) was 'severely impaired.' She remembered 2 out of a possible 21 'ideas' in both immediate and delayed recall of the Story Recall component of the test and could not name the current Prime Minister. CJ scored in the abnormal range in both the Camden Memory Test (Warrington, 1996) and the Rey Figure (Rey, 1941). Her performance on the TEA (Robertson, Ward, Ridgeway, & Nimmo - Smith, 1994) Elevator Count with Distraction was at the 10 - 25th % ile. CJ considers that her ability to read and spell and understand the meanings of words has been substantially affected since the operation and reports severe difficulties remembering recent events and facts as well as demonstrating some retrograde amnesia for such things as the names of neighbours and recipes for favourite family meals. After six months of twice weekly training sessions with the same researcher she still could not reliably remember the researcher's name and many practice phrases she had typed hundreds of times during the course of her training remained unfamiliar to her. Before the study, CJ had never typed or used a computer. Both CJ and her family expressed severe doubts about her being able to learn to touch type.

*LH.*

LH is a 38 - years - old former self - employed builder who suffered a sub - arachnoid haemorrhage two years before the start of the study resulting in left hemisphere lesions. He had been unable to work since the haemorrhage due principally to being unable to keep track of the progress of jobs or negotiations with customers. At the time of the study, LH's Full Scale IQ score on the Wechsler Adult Intelligence Scale (WAIS - III) (Wechsler, 1997) was at the bottom end of 'average'. His screening score assessed by the Rivermead Behavioural Memory Test (RBMT) (Wilson et al., 1991) indicated a moderately impaired memory. He recalled 7.5 out of 21 'ideas' in the immediate recall condition of the Story Recall test and two in the delayed component. LH scored below chance on the Camden Memory Test (Warrington, 1996) of word and face recognition and his scores on the Rey Figure (Rey, 1941) were abnormal. His performance on tests of attention was abnormal under challenge: on the Stroop (Trenerry, Crosson, DeBoe & Leber, 1989) Colour/Word condition he scored at the 5 - 6th % ile and on the Test of Everyday Attention (TEA) (Robertson et al., 1994) Elevator Count with Distraction he was at the 10th % ile. LH recounted having problems remembering recent events, the names of members of his family, what he has read in the newspaper, whether or not he has eaten

meals, what people have told him and following instructions. Although he had been keen to learn computers, his experience of attending one computer class (where he had been unable to remember what was said or to follow the written notes) had prevented completion of the course and knocked his confidence. He expressed severe doubts about being able to learn to touch type, as did his family.

#### *TT.*

TT is a 60 - years - old man who has used a word processor and other computer programmes for many years as part of his job as a journalist and radio producer. He has no brain injury and no problems with memory in everyday life. He was a very competent two-finger typist at the beginning of the study, but had never learned to touch type. TT was confident that given enough practice he could learn to touch type, though he felt his current style of typing would interfere with his learning.

#### *IR.*

IR is female, aged 37. She has no brain injury and reports no problems with memory in everyday life. However she suffers from Ménière's disease which anecdotally can lead to forgetfulness, feelings of confusion, disorientation, and/or sensory overload. It is reasonable to assume that the symptoms of tinnitus and vertigo, which characterise the complaint, could affect IR's concentration. At the start of the study IR had not been in paid work for two years because of her illness. She had very occasionally used a computer, but had not learned to touch type. IR was confident that she could learn to touch type. She withdrew from the study after reaching the criterion of typing at ten words a minute with over 90% accuracy.

### **Procedure**

Individual one-to-one training took place two mornings a week. Training was carried out by the researcher, a psychologist who was also a touch typist trained on the "KAZ" system using the text version which presents written instructions on the screen. The instructional software was unadapted, however, the training was distributed over short sessions, rather than massed into longer sessions as recommended by the manufacturers for normal learners.

The criterion levels for each stage were determined by the researcher, participants were allowed as many sessions as necessary to reach criterion. For the memory-impaired participants, the researcher navigated the system using the mouse and on - screen instructions were explained, repeated or demonstrated as required. The researcher attempted to provide error-free conditions by preventing mistakes, for example, by touching the participant's correct finger, physically placing the finger on the correct key, pointing to the key guide displayed on the computer screen, or offering prompts and

reminders such as 'right hand, little finger, top row on the right,' if the participants with memory impairments hesitated over which key to press or which finger to use. When this happened the researcher insisted that the keystroke was tried again several times until it was correct in an attempt to overlearn the correct response. The comparison participants were offered the same one-to-one training as the participants with memory difficulty, but after the first session TT preferred to follow the on - screen instructions himself and did so throughout the training. However he continued to record the time/number of sessions taken to reach criterion levels. IR received one - to - one lessons, but had minimal interaction with the researcher during them.

Encouragement, reassurance and praise were offered throughout the training. If the participants became tired or frustrated they were encouraged to take a break and relax for a few seconds before replacing their fingers on the home keys. Training was carried out in three stages corresponding with the way in which new skills are acquired.

*Stage 1: Acquisition of the position of the twenty-six alpha keys.* The acquisition stage, involved gaining knowledge of the correct finger reaches for all the twenty-six alpha keys by typing a fixed set of phrases. The participants were taught to position their fingers on the central row of 'home keys,' which are the reference point for all other keys on the keyboard. Keys F and J have raised bumps which are located by the index finger. The three other fingers cover the rest of the keys in the row, while the right thumb remains on the space bar. They were then shown how to make the finger reaches to enable them to type five set phrases, which together incorporate all the letters of the alpha keyboard. The phrases (if mike jived; rude dunce; slap now; baggy hat; extra quiz) were taught one at time over five sessions. Each session continued until the participant reached the criterion of typing the target phrase three times without error, without help and without looking at the keyboard. At the beginning of sessions 2 - 5 the participants were required to demonstrate they could type the phrase or phrases acquired in previous sessions once before progressing to the next phrase. The length of time taken in re - attempting criterion was added to the participants' total learning time for that phrase.

*Stage 2: Consolidation and transfer of learning.* In this stage participants' knowledge of the individual keys was consolidated and transferred through the typing of computer-selected subsets of words and phrases. The participants were required to transfer their knowledge of the positions of the keys to being able to type the letters in different orders to form new words, phrases and sentences generated by the computer. At this stage they also learned how to operate the shift keys for upper case letters, the punctuation keys and the number keys. During this stage the visual key guide is removed from the computer screen and as performance improved fewer prompts were needed until participants could use all the keys without prompting. The criterion for moving on from stage two was the ability to type a list of ten short sentences, three times without error and without prompts from the researcher.

*Stage 3: Performance in speed and accuracy.* This stage involved improving performance of speed and accuracy through regular practice, which took place independently and in 48 sessions of observed trials. Participants were required to type a set of twenty sentences randomly selected by the computer from a pool. The computer displays the speed and accuracy for each sentence and the average speed and accuracy for groups of twenty sentences. This is a stringent method of recording speed and accuracy as, once an error has occurred, typing is halted until the correct key is used but additional key presses are recorded as errors. Therefore each time a key, space bar or shift key is wrongly struck (which may happen several times before the typist discovers the mistake), the action detracts from the accuracy score and slows the completion speed. However the computerised system does allow the typist to pause between each of the sentences. Participants were expected to reach criterion levels of initially 10 wpm with over 90% accuracy (mean of twenty sentences) and, if they wished to continue, 20 wpm with over 90% accuracy. In fact the participants with memory impairment continued to practice beyond these criteria and this is reported in the results section. Scores were recorded over 48 observed trials for each participant.

*Stage 4: Skill retention.* The participants with memory impairment and TT were tested twelve months after completing the study using the speed and accuracy measures of Stage 3.

## RESULTS

### **Stage 1: Acquisition of the position of the twenty-six alpha keys**

All participants successfully completed acquisition of the five phrases which incorporate all the lower case letters of the alpha keyboard in the minimum number of five sessions, although individual sessions varied in length from 15 to 60 minutes. Over the five sessions the participants with memory impairment, LH and CJ, took a similar amount of time, 140 minutes and 146 minutes respectively, to complete this part of the training. Comparison participant TT spent the longest time of all the participants on this task, 220 minutes in total while comparison participant, IR took least time (121 minutes) (Table 3.2)

Table 3.2: Performance during three stages of touch typing acquisition and retention

|         |                                | LH   |       | CJ   |       | TT   |      | IR    |      |
|---------|--------------------------------|------|-------|------|-------|------|------|-------|------|
| Stage 1 | No. of Trials                  | 5    |       | 5    |       | 5    |      | 5     |      |
|         | Total mins.                    | 140  |       | 146  |       | 220  |      | 121   |      |
|         | Mean                           | 28   |       | 29   |       | 44   |      | 24    |      |
|         | Standard deviation             | 8.3  |       | 6.9  |       | 9.4  |      | 10.57 |      |
| Stage 2 | No. of Trials                  | 13   |       | 12   |       | 4    |      | 16    |      |
| Stage 3 | No. of Trials *                | 48   |       | 48   |       | 48   |      | 14 ** |      |
|         |                                | Wpm  | % Acc | Wpm  | % Acc | Wpm  | %Acc | Wpm   | %Acc |
|         | Highest wpm and accuracy score | 30   | 82    | 32   | 98    | 24   | 93   | 11    | 95   |
|         | Mean wpm and accuracy score    | 20.7 | 87.8  | 21.8 | 96.6  | 17.7 | 94.5 | 8.5   | 94.6 |
|         | Standard deviation             | 6.3  | 6     | 5.2  | 2.2   | 3    | 2    | 1.3   | 0.9  |
| Stage 4 | Mean retention score           | 24   | 82    | 26   | 97    | 24   | 97   | ----- |      |

\* Trials at Stage 3 indicate observed sessions

\*\* IR withdrew when her speed reached 11 wpm with 95% accuracy and was unavailable for retention

### **Stage 2: Consolidation and transfer of learning**

The two participants with memory impairment, LH and CJ together with the comparison participant IR, required at least three times as many sessions to reach criterion than the comparison participant, TT, who took only four sessions (LH: 13; CJ: 12; TT: 4; IR,16).

### **Stage 3: Performance in speed and accuracy**

The criterion of 20 wpm with at least 90% accuracy was attained by LH on the 18th trial, by CJ on the tenth trial; and TT on the 25th. IR withdrew from the study on Trial 12, after attaining the first criterion of 10 wpm at 95% accuracy (without any concurrent practice). Her speed and accuracy



performance was similar to that of TT and LH, but because they are limited in scope they are not shown in Figs.3.1 and 3.2.

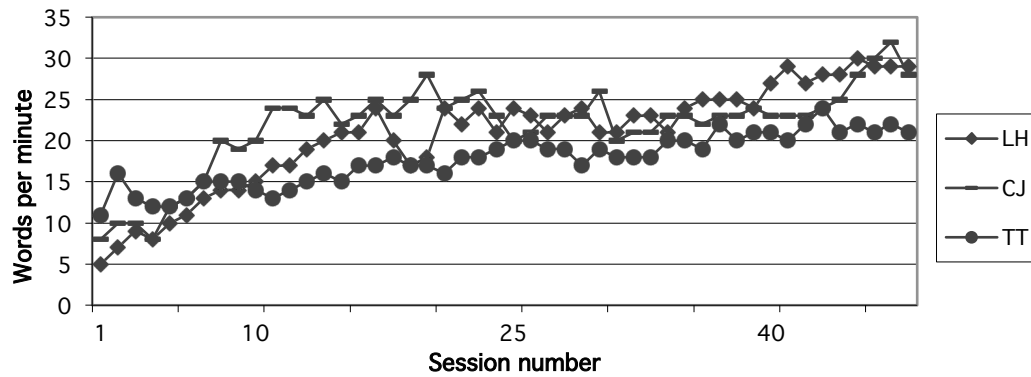


Fig:3.1: Speed in words per minute over 48 trials.

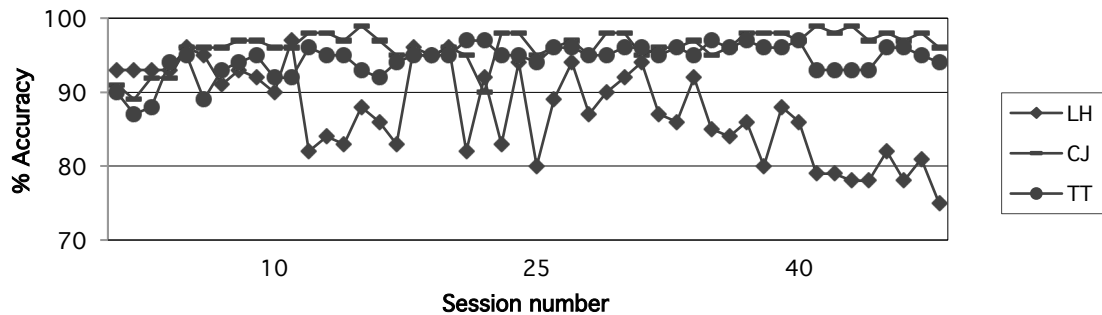


Fig 3.2: Percentage accuracy over 48 trials.

Figs. 3.1 and 3.2 show the evolution in speed and accuracy of the other participants over 48 observed trials. During speed and accuracy training (Stage 3), participants also practiced between observed trials either at home or in the centre without supervision.

*Speed.* The overall pattern of the results in Figure 3.1 shows increments in speed for all participants with an irregular falling back followed by a gain. The mean scores of the memory-impaired participants over 48 trials were three or four words per minute higher than those of the comparison participant TT. CJ's top speed in an individual trial was 32 wpm with 98% accuracy; LH's 30 wpm with 82% accuracy and TT's 24 wpm with 93% accuracy. However LH and CJ's speed scores fluctuated more between trials than those of TT as reflected in the standard deviation (Table 3.2).

*Accuracy.* CJ and TT consistently maintained accuracy levels over 90% for all trials except for occasional trials at the start (trial 2 for CJ and trials 2 and 3 for TT) ( Fig 3.2). CJ showed consistently high accuracy scores, up to 99%, seemingly unaffected by increasing speed. TT's accuracy scores,

though lower, follow the same general pattern in that they are maintained despite increases in typing speed. On the other hand, LH's scores show a markedly different pattern, fluctuating widely between sessions after his speed exceeded 15wpm; at 30 wpm, his accuracy dropped to his lowest score of 75 % in session 48. LH's mean accuracy was the lowest of the participants (88%) and showed more variability than CJ and TT as reflected in the standard deviations (Table 3.2).

#### **Stage 4: Skill retention and skill transfer**

In a test twelve months after completing the study, CJ scored 26 wpm at 97% accuracy, LH 24 wpm with 82% accuracy and TT 24 wpm with 97% accuracy (Table 3.2). Both successfully transferred their touch typing skill to use unadapted word processing software. After completing the 48 trials both used their touch typing skills in their everyday lives, to type documents and send email.

## **DISCUSSION**

The mean speeds of the participants with memory impairments were higher, but showed more variability between sessions than that of comparison participant TT. However, the two most striking results are the decrement and increased variability in the accuracy scores of LH as his speed increased as opposed to the consistently high accuracy and lack of variability in the accuracy scores of the other participant with memory impairment, CJ and comparison participant TT, which were unaffected by increased speed. LH's variability in accuracy could be an artefact of a natural trade - off between speed and accuracy and may have been shown to be in the normal range if more participants had been included (as could the speed variability of both LH and CJ). Another reason may lie in the difference between CJ and LH on their attention test scores. LH's performance was abnormal under challenge, whereas CJ's was at the lower limit of the normal range, which may have predicted a drop in attentional capacity as speed increased leading to decrements in accuracy. There is also the possibility that LH, despite achieving criterion at Stage 2, had not reached the same level of automaticity as the others and in fact could have benefited from more repetition to ensure overlearning had taken place. Reverting to Stage 2 for extra training when his accuracy began to drop off may have rectified the problem. This would partly accord with Hauptmann et al.'s (2006) contention that saturation of learning at an early stage is necessary to trigger delayed gains in performance.

The results support the research hypothesis that two people with impaired memory were capable of acquiring the complex perceptual motor skill of touch typing to a comparable level with the comparison participants under the learning conditions described. This study, therefore, lends weight to the proposition that people with impaired memory can acquire and retain a complex real world

perceptual motor skills to a useful level. Over thirty weeks, to the end of the study, the two participants with memory impairment learned to touch type at speeds over 20 wpm – each with a top speed in an individual trial of 30 wpm or more - and retained their ability a year later. This compares well with the 15 - 25 wpm normal learners are required to achieve on touch typing courses such as the first Pitman Computer Keyboard Skills course and with the performance of the participant without memory impairment, TT. The results of this small-scale study imply that the findings using simple tasks in the laboratory may apply to more difficult real-world skills, at least if support is provided during learning. They also suggest that teaching useful perceptual-motor skills to people with memory impairments may be a way of capitalising on their preserved abilities, representing one fruitful way forward in memory rehabilitation, if suitable ‘pure’ motor skills can be identified.

Since both CJ and LH scored in the abnormal range on tests of explicit memory it seems reasonable to speculate that the skill was acquired principally through procedural memory, as intended. In particular, the fact that CJ, whose memory was classed as ‘severely impaired’ on the RBMT, outperformed the other participants in terms of both speed and accuracy, points to her learning having been achieved through the procedural route, though some reliance on residual explicit memory cannot, of course, be ruled out. With regard to CJ’s superior performance it should be noted that she may have put in more practice than the other participants at Stage 3 when they were allowed to practice independently, although informally all said they practised about three times a week. However it could be argued that CJ’s severely impaired explicit memory conferred an advantage on her in motor skill learning, with the caveat that she was taught under errorless conditions. Whereas explicit processes appear to function by identifying and eliminating errors during learning, implicit processes encode frequency information and are unable to correct errors. Reducing or eliminating mistakes is therefore indicated for implicit learners who otherwise may unselectively encode all action outcomes regardless of success, leading to repetition of mistakes (Wilson, 1994). As far as motor skills are concerned it has been proposed that implicit learning is superior to explicit learning for normal learners of motor skills and that suppressing the accumulation of explicit knowledge during the early stages of learning leads to more effective performance and confers robustness when participants are expected to perform with additional cognitive load (Maxwell et al., 2001; Orrell et al., 2006; Poolton et al., 2005). Maxwell et al., (2001), who used error free techniques in golf training, point out that robustness of performance under stress is a desirable quality for all participants in sport, but it could be equally appreciated by people with memory impairments who have learned to touch type, if the skill remains robust under the added cognitive load of, for example, learning other computer operations or typing in a noisy office. Other work in the field of motor skill learning supports the contention that errorless learning inhibits the acquisition of explicit knowledge in normal learners and that this leads to durability of motor learning by promoting a permanent change in behaviour (Orrell, et al., 2006). It may follow then that if explicit memory is already impaired, as in CJ’s case, there is naturally less tendency for the person to attempt to

employ explicit processes, and therefore it is proportionally easier to promote procedural learning by the use of errorless techniques. This is consistent with the review of (Evans et al., 2000) who note that people with more severe memory impairments gain more from errorless procedures in non-motor learning than the less severely impaired. This has led to calls for further elucidation of the types of tasks which benefit from errorless learning, the level of impairment of the participant and mechanisms involved (Evans et al., 2000). Encouragingly for people with severe memory impairment an indicator of the success and retention of perceptual-motor skill learning could be their low scores on explicit memory tests.

Success in learning to touch type may have been predicted for the participants with memory impairments because, though much more complex and taking much longer to learn, touch typing shares characteristics with the types of the tasks which people with memory impairments have been shown learn successfully (e.g. Brooks & Baddeley, 1976; Gauggel & Fishcher, 2001). The outcome, or performance of these tasks involves assessing them in an identical situation to that in which they were learned in terms of perceptuo-motor and cognitive demands (Evans et al., 2000). Both participants with memory impairments in this study went on to use their touch typing skills in their everyday lives to produce a variety of documents using standard word processing programmes, and to use email. They used different computers in various settings to perform a range of tasks, so that it appears that the presentation of a standard QWERTY keyboard is enough to trigger performance of the skill regardless of the setting and that it can perhaps withstand some variability in extra cognitive demand. This is worth noting because a major drawback of teaching specific motor skills for rehabilitation is their constrained practical application. While the learners may improve specific skills, their expertise does not generalise to other, similar tasks. When real world skills are taught (e.g. a client may learn to sort mail, and successfully transfer this specific skill to a work environment), the skill remains very specific and does not generalise to other similar tasks (Parenté, Twum & Zoltan, 1994). Touch typing, on the other hand, while it may not generalise to other tasks, can feasibly transfer to a multiplicity of computer functions and circumstances as long as they are performed using a QWERTY keyboard.

Observations of learning in people with memory impairments have led to calls for the “proceduralisation” of tasks which people with memory impairments find difficult with the aim of maximising spared aspects of their memory (Wilson, 1987, p.60). However, ‘proceduralising’ a task which normally relies on input from explicit memory and other cognitive functions, such as programming an electronic organiser or following a route, is perhaps necessarily more difficult than teaching a ready made procedural skill such as touch typing. However, use of the keyboard can be acquired in two different ways and provides a characteristic example of a skill which can be proceduralised by changing the way in which it is learned. Hunt and peck involves visually scanning the keyboard for the correct key, and, it is argued here, involves a type of learning which requires explicit resources (Anderson, 1983; Beaunieux et al., 2006; Berry & Broadbent, 1984, 1988). However,

touch typing training as employed in this study, does not require explicit cognitive resources as the performer is not required to look back to past errors or test hypotheses about past performance. Instead performance is improved by relatively passive acquisition of successful action-outcomes leading to a knowledge base which is not easily verbalised (Maxwell et al., 2001).

Performance in motor skill is supported by a gradual increase in successful action -outcome contingencies (Maxwell et al., 2001). In the case of touch typing, this success means that the correct finger reach is employed resulting in the correct letter appearing on the screen. As this incremental success differs from person to person no specific protocol could be laid down for coaching. It is a fluid and dynamic process and there are no set limits to the amount of prompting necessary; it stops when the participant gets it right. Because of the nature of the task mistakes cannot always be pre-empted as the learner may strike the wrong key before a prompt can be given. The participants with memory impairments did not resist the prompts and asked for them when they were uncertain about which key to press, while, in contrast the comparison participants balked at attempts to impose errorless conditions and preferred to follow the computer-generated instructions themselves and to guess when they could not remember the position of a key. This suggests that the comparison preferred to employ a strategy of learning by their mistakes, an option which would have been less effective for CJ and LH and may also have been less than optimal for normal learners (Maxwell, et al., 2001; Poolton, et al., 2005). Significantly the memory-impaired participants also forgot which of the keys had presented particular difficulty, but these could be noted by the coach who singled them out for more practice. They also expressed difficulty in following the on-screen commands as has been highlighted by Clegg and Rowe (1996).

This study was concerned with providing ecological validity to the results of motor skill training in the laboratory by demonstrating that they can be replicated using a real-world skill. The researchers considered that the methodology was sufficient, for practical and ethical considerations and because of the time consuming procedure. It represented a successful attempt to train the participants in a useful skill and we maintain adds weight to the findings of other work on facilitation of motor learning, for example on errorless versus errorful learning (e.g., Maxwell et al., 2001); massed versus distributed practice (e.g., Baddeley & Longman, 1978; Duke & Davis, 2006; Shea et al., 2000); the benefits of coaching (Clegg & Rowe, 1996), guided practice (Wulf & Weigelt, 1998), and standardised repetition of learning sessions (Wickens, 1989), although the experimental design used does not allow conclusions about the specific contribution of learning conditions in this study. Further work could be done to extrapolate which conditions are most effective in the teaching of touch typing, but in a real world situation using a complex skill, practicalities may stand in the way. Observations of the participants with memory impairment in this study point to it being highly unlikely that they could have learned to touch type through self-instruction, making some kind of coaching necessary. The role of any coach is to correct the learner, therefore imposing, to some extent, errorless conditions. Touch

typing requires much practice, and people with brain injuries tend to fatigue easily and lose concentration, therefore it is difficult to use long periods of massed rather than spaced repetition. More investigation is needed on teaching the those with more severe memory impairments to touch type or to perform other useful motor skills which could benefit their home and work lives, for example learning to play a musical instrument, operating a calculator, or welding electrical connections on a circuit board. However the instinctive approach to teaching, which is to provide explicit instructions and background information about the task in hand may, counter intuitively, be detrimental in the early stages of learning a motor skill even in normal learners (Poolton et al, 2005). Also, in their work teaching stroke patients to balance, Orrell et al (2006) postulate that giving verbal or written instruction during learning makes extra demands on compromised explicit memory and information processing ability, representing a concurrent cognitive task. This may encourage stroke patients to attempt to consciously control their movements, which paradoxically disrupts optimal performance. As far as touch typing is concerned, it may be that the best approach is to severely restrict explicit instructions and to discourage attempts on the part of the learner to consciously memorise the keyboard by, for example, using a mnemonic. More investigation is needed into the effects of explicit instruction on teaching memory-impaired people to perform motor skills. Learning what to say and what not to say may be an important addition to the role of the coach.

## CHAPTER FOUR

### **4.1 To tell or not to tell: Instruction-free learning as an adjunct to error-reduction in perceptual motor skill learning for people with explicit memory impairments.**

#### INTRODUCTION

As reported in the previous study, people with explicit memory impairments retain the ability to learn new simple motor skills in the laboratory and some complex procedural everyday skills such as touch typing if they are taught under conditions which appear to suppress the use of explicit memory; in particular the employment of error-free protocols in which mistakes are minimised during task acquisition. Nevertheless, apart from a large body of work reporting the predominantly beneficial effects of error-free learning on tasks including motor skills, there is a paucity of research into other ways in which the learning of everyday useful motor skills can be further optimised by this group of people (Cavaco et al., 2005) or applied in circumstances which do not lend themselves to error-reduction. In the majority of teaching situations knowledge is imparted through verbal instructions or written explanation, while the more difficult the learner finds the task, the greater the urge on the part of the teacher to explain.

This study explores the perhaps counter-intuitive hypothesis that repeatedly telling learners with memory impairment what to do as they practice may hinder the acquisition of a real world perceptual motor skill by overloading verbal working memory and/or promoting a spurious reliance on defective explicit recall. It is suggested that a more helpful approach may be to allow learning to arise implicitly from repeated voluntary body movement, visuo-spatial feedback or simple exposure. To examine the proposition that instruction-free learning may be a useful adjunct to errorless protocols, this study compares the performance of two groups of people with explicit memory difficulty as they attempt to acquire the perceptual motor skill of golf putting under error-reduced conditions: one group being given spoken instructions between task trials; the other simply being advised to do their best. Golf putting was chosen as it lends itself to implementation of error-free protocols (Poolton et al., 2005) and represents an analogue for other useful everyday motor skills.

Motor skills have in common the ability to coordinate the action of muscles to produce a specialised movement, finely-tuned to accomplish a certain goal and do not require the conscious recall

of instructions for their execution (Maxwell et al., 2008). They include everyday skills, which become automatic through practice, such as riding a bike; playing the piano, touch typing and operating machinery. Learning is characterised as “gradual and iterative, acquired over many trials, slowly moving towards a particular goal” (Petersen, Van Mier, Fiez & Raichle. 1998, p.853) and in some cases can take place with little attention being given to the task in hand (Cohen, Ivry, & Keele, 1990).

From a cognitive and neurological perspective it is well established that memory is not a single entity but involves multiple systems (e.g. Cohen, 1984; Cohen & Squire, 1980; Schacter, 1987; Tulving & Markowitsch, 2008)<sup>1</sup>.

A major division of long term memory involves the distinction between explicit or declarative memory for facts and life events, which can be spoken of and consciously brought to mind; and implicit memory which underlies many unconscious and hard to verbalise functions including habit learning, priming and procedural motor skills. In general the Papez circuit: the hippocampi, medial temporal lobe structures and their links to the temporal and frontal lobes, mediate declarative memory. These areas are highly vulnerable to damage because of their position in the brain; accounting for the anterograde episodic and semantic memory problems commonly displayed by people with brain injuries. A separate set of basal ganglia structures - the putamen and caudate nucleus - together with the cerebellum, are implicated in the various types of implicit memory, including procedural motor skills. These structures are relatively resistant to pathology (with some notable exceptions, for example Parkinson’s disease and Huntington’s disease). Cognitively, there is robust evidence of a double dissociation between the memory systems involving the hippocampus and those reliant on the caudate nucleus, providing converging evidence that there are at least two such systems operating in a normal brain (Packard, Hirsch & White, 1989). Damage to the explicit memory system, combined with preservation of the neurological structures responsible for implicit learning, means that many people with declarative memory problems are known to retain the capability to acquire new motor skills (Petersen et al., 1998; Squire and Zola, 1996).

It is suggested here that optimisation of this valuable potential may involve controlling the learning process so that it takes place in conditions which selectively recruit and engage intact procedural memory by precluding or reducing the involvement of explicit memory. Further that this should be done in the early stages of acquisition to prevent the accrual of undesirable responses which must later be ‘unlearned,’ (Singer, 1977). Findings in humans and in rats emphasise that what is important is not only the task that is to be learned, but also what strategy is implemented during learning, which in turn reflects which memory system is engaged: in some circumstances the cognitive strategy unconsciously employed is not optimal for the task (Squire, 2004). For example rats with

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<sup>1</sup> There are dissenters from this view. For example Whittlesea & Price (2001 p244) “We argue that there is only one memory system which preserves all experiences and is used in all tasks. It is never accessible to consciousness” who argue that there are multiple processes operating on this single system or multiple ways of accessing its contents.



hippocampal lesions, have been shown to be *better* at learning a maze task involving a single response to a specific sensory cue (repeated visits to illuminated arms) than those with intact hippocampi (Packard et al, 1989), presumably because rat hippocampal lesions disrupt reliance on the parts of the brain which evolved to underlie declarative memory in humans. This suggests that a declarative learning strategy would not be the best option in this procedural task, mirroring the difficulties humans have in trying to memorise what they are doing when acquiring a difficult habit-learning task Squire (2004). Also, fMRI studies have demonstrated that in some cases the brain areas involved in different types of memory appear to actually compete with each other for control of learning and that engagement of the brain areas involved in either declarative or implicit memory is modulated by whether the task *encourages* the relevant type of learning (Poldrack, Clark, Paré-Blagoev, Shohamy, Cresco Moyano, Myers & Gluck, 2001). For example there is now substantial evidence that some types of learning are facilitated in learners with memory impairment if the ability to internally generate explicit memory is suppressed using error-free paradigms (e.g. Wilson et al., 1994; Hunkin et al., 1998); Evans et al., 2000, Maxwell et al., 2001). In particular, there is mounting evidence that error-reduction is a key variable in the initial acquisition phase of highly proceduralised tasks for people with moderate to severe explicit memory impairments (Sohlberg & Turkstra, 2011), such as touch typing (Todd & Barrow, 2008), route recall (Lloyd, et al., 2009) and individualised memory interventions (Campbell et al., 2007). Also in the acquisition of motor-skills, which involve a sequence of action-outcome contingencies, error reduction confers distinct advantages over practice in which mistakes are made (Maxwell et al., 2008). This necessarily means by-passing as far as possible the involvement of verbal working memory. Since working memory is predominantly a verbal system, learning that is accompanied by high levels of working memory involvement is likely to be explicit, but when the participation of working memory is reduced or minimal learning is more likely to be implicit (Maxwell et al., 2008). Maxwell et al. (2008) posit that it is only early in the acquisition process that errors need to be minimised because it is then that a stable, concrete platform is established to support later performance. Mistakes made early in learning will tend to be repeated and become entrenched, making them harder to extinguish later.

Conventional teaching of procedural tasks in which an instructor provides explicit verbal or written instructions and explanations as learning progresses, equates with traditional learning theory, the basis of which is that normal skill learning must begin with explicit knowledge and proceed to implicit learning once some stage of competency has been reached. An early cognitive phase in skill learning assumes that there is a period in the initial stages of skill acquisition during which memory may benefit from ‘intellectualisation’ of the task in hand. Fitts and Posner (1967) illustrate this approach with an account of the training of novice aircraft pilots whose flight training was cut from ten to three and a half hours when they were given extensive, detailed discussions of each flying manoeuvre between very brief training flights.

In terms of rehabilitation, stroke patients for example may be presented with complex instructions on how to perform motor tasks and be encouraged to evaluate performance outcomes (Orrell et al., 2006). Yet there is a small body of evidence suggesting that this approach may not be optimal and that spoken instruction may be detrimental to some normal learners and stroke patients, at least in the early stages of learning a motor skill (Boyd & Winstein, 2004; Orrell et al., 2006; Poolton et al., 2005). For example explicit instruction was detrimental to performance of a ski-simulator skill in normal learners (Wulf & Weigelt, 1997). Also, working with people with normal memory, Poolton *et al* (2005) demonstrated that giving explicit instructions throughout the first 150 learning trials in a golf-putting task was less effective than when no explicit instructions were given until after 150 trials. In work teaching stroke patients to balance, Orrell et al. (2006) found that the balance performance of a group given explicit instructions was impaired by the imposition of a secondary cognitive load compared to that of uninstructed implicit learners, implying that skills learned without explicit instructions are more robust in the face of interference. Orrell et al. (2006) did not test the memory ability of their participants, but concede that cognitive defects occur as a corollary to stroke. They postulate that giving explicit instruction during learning made extra demands on compromised information processing ability and led stroke patients to attempt to consciously control their movements, which paradoxically disrupted optimal performance. They suggest that the provision of explicit information during rehabilitation may be detrimental during learning or re-learning of motor skills in some people with stroke and that implicit motor learning techniques in rehabilitation may be beneficial.

Boyd & Winstein (2006) demonstrated that explicit instruction interfered with the learning of continuous and discrete movements in laboratory motor tasks (serial reaction time and continuous tracking) in patients with stroke affecting either the sensori-motor cortex or the basal ganglia, regardless of type of task or lesion location. In earlier work, the same researchers (Boyd & Winstein, 2004) found that provision of explicit information across three days of practice in a motor sequence task hindered its acquisition in participants with basal ganglia stroke but not healthy controls. In a retention task on the fourth day there was a difference between groups. Explicit information again hindered performance in participants with basal ganglia lesions, but aided controls. The researchers concluded that basal ganglia integrity may be a crucial factor in determining whether people would benefit from explicit instructions when learning motor sequence tasks: when the putamen is damaged explicit instruction appears less helpful in the development of a motor skill than is discovering a motor solution implicitly, perhaps due to increased load on working memory.

That basal ganglia lesions disrupt motor skill learning (Boyd & Winstein, 2004, 2006) is consistent with the recognised dependence of explicit and implicit memory on separate neurological underpinnings. We would expect motor skill learning to be disrupted in those with damage to the basal ganglia structures which mediate skill acquisition. However the implication that conscious explicit

processing of instructions disrupts implicit learning of motor tasks in people with damage to the basal ganglia, specifically the putamen, opens a new area of speculation about the interaction between implicit and explicit memory processes and implies links between basal ganglia structures and explicit memory. Indeed evidence is emerging that the distinction between the two memory systems is not as clear-cut as previously imagined, and that no single set of structures underlies performance in cognitive tasks (Ell, Helie & Hutchinson, 2012). One basal ganglia component, the putamen, long established as critical in many aspects of motor learning, is now suggested as being involved in a number of non-motor cognitive abilities. Though more work is needed to identify the specific role of the putamen in cognition, the left putamen has been consistently implicated in the encoding of verbal episodic memory (Prince, Daselaar & Cabeza, 2005; Sperling, Chua, Cocciarella, Rand-Giovannetti, Poldrack & Schacter, 2003; Ystad, Eichele, Lundervold & Lundervold, 2010) and in working memory (Baier, Karnath, Dieterich, Birklein, Heinze & Muller, 2010; McNab & Klingberg, 2008).

Evidence is also emerging that motor learning is not a single process: different neural systems are thought to be involved at different stages, according to the amount of practice undertaken and as learning progresses from its early stages to more skilled performance a dynamic change takes place in the brain areas involved. Petersen et al. (1998) examined differences in brain area activity during unskilled and skilled performance in normal learners. They found some similar brain areas, i.e. the visual and motor cortices, were activated throughout a motor skill-learning task (maze tracing). However the right premotor and parietal cortex and left cerebellar hemisphere were significantly more activated during initial unskilled performance while a different region, the medial frontal cortex supplementary area, showed greater activity during skilled performance. They interpret this in terms of a 'scaffolding-storage' framework in which one set of regions is used to cope with the novel demands of the task in the early stages of learning, whereas, following practice, a different set of regions comes into play, possibly representing storage of the particular associations that allow for skilled performance across time. They add that the difference between first attempts at learning a perceptual motor task, such as learning to drive, appear so different from skilled driving that they seem to be qualitatively different tasks which might be expected to utilise different neural mechanisms. Petersen et al (1998) deduced that the early stages of learning, which involve pattern recognition, can be explicit, involving problem solving and conscious recognition of what needs to be done, or in other cases this initial learning may be implicit. They conclude that later phases of learning involve correction of errors before a final stage in which overlearning occurs and less effort and attention is needed.

In other work, neuroimaging studies have implicated multiple neural mechanisms in motor skill learning, including the fronto-parietal cortices and interconnecting regions in the basal ganglia and cerebellum. For example the dorso-lateral pre-frontal cortex and the presupplementary motor area have been shown to be activated in the early stages of learning and more parietal areas in the later stages of skill acquisition (Hikosaka, Nakamura, Sakai, & Nakahara, 2002). Hikosaka et al. (2002) propose two

separate orthogonal loop circuits mediating ‘spatial sequence,’ and ‘motor sequence’ learning, operating independently, both of which are optimised by the basal ganglia and cerebellum. In their terms, spatial sequence learning is quickly acquired, involves working memory and requires maximum attention. It is accurate, but slow, and involves a circuit between the pre-frontal parietal cortex and the motor region of the basal ganglia and cerebellum. Motor sequence learning - which in their terms is slowly acquired, with minimum attention and in which speed is maintained without awareness - involves a circuit between the motor cortex and the associative areas of the basal ganglia and cerebellum. The distinction between the early and later stages of learning provides an explanation for why uninstructed, implicit learning may be more useful in the early trials of a learning task (Poolton et al., 2005). At this early stage of the ‘scaffolding-storage’ framework, before automaticity sets in, learning may be implicit or explicit (Petersen et al., 1998). In later stages explicit learning can be introduced to aid with error correction and the refining of the skill. It is suggested here that, in people with memory problems, early introduction of verbal instructions may encourage the learner to engage faulty explicit learning processes and discourage the more optimal strategy, which in this case would be predominantly implicit. In this situation, the learner may never reach the second post-automatic ‘scaffolding’ stage where learning is refined and becomes more sophisticated.

A major issue, which may affect motor skill learning, is that of the integrity of working memory and attentional processes. Normal learning requires the integration of incoming verbal and visuo-spatial information into long-term memory. Information, such as instructions on how to carry out a task, must be attended to, manipulated, sorted and held on line in the very short term before this can occur. Baddeley’s (1986) widely accepted model of a cognitive system of working memory, which lacks storage ability, but acts as a conduit to long term memory, provides an explanation for how this occurs in the normal brain (e.g. Baddeley, 1986, Baddeley, 2000). fMRI studies have implicated the pre-frontal cortex in the functioning of the ‘executive’ or attentional control system of working memory (D’Esposito, Detre, Alsop, Shin, Atlas & Grossman, 1995), while PET studies have demonstrated a double dissociation in the neural circuits underlying the spatial/perceptual and verbal functions of working memory, with verbal tasks engaging primarily left hemisphere regions and spatial tasks the right hemisphere (Smith, Jonides & Koeppel, 1996). The proposed distinction between different types of working memory has backing from studies which show that normal, healthy people can carry out two tasks simultaneously with little decrement in performance provided the tasks chosen rely on different (verbal and visuo-spatial) aspects of the cognitive system and that the two tasks are similarly demanding (Logie, Della Sala, Cocchini & Baddeley, 2000). However people with severe traumatic brain injury have been shown to have working memory impairment due to central executive damage, demonstrated by their showing greater decrements in reaction time than normal controls using a dual-task paradigm (McDowell, Whyte & D’Esposito, 1997). There is also a suggestion that some of the memory complaints seen after mild traumatic brain injury may be linked to changes in ability to

activate or modulate working memory processing (McAllsiter, Sparling, Flashman, Guerin, Mamourian & Saykin, 2001), while people with Alzheimer's disease show specific and progressive decrements when performing dual memory-loaded tasks (Baddeley, Bressi, DellaSala, Logie & Spinnler, 1991; Della Sala & Logie, 2001). There is also converging evidence that the difficulties that children born prematurely and those with cerebral palsy encounter in learning motor tasks could be in part due to compromised working memory ability (Steenbergen, Van Der Camp, Verneau, Jongloed-Pereboom & Masters, 2010)

Normal motor learning, is considered to be acquired initially through verbally based explicit learning before passing on to an automated or implicit phase when the verbal rules are forgotten and processing becomes unconscious, a process known as cognitive procedural learning (Beaunieux et al., 2006). The performer is assumed to learn by 'hypothesis testing,' intuitively referring back to prior errors so that they will not be repeated (Anderson, 1983) using working memory as an error-detection and correction mechanism, crucial to the development of declarative knowledge (Baddeley & Wilson, 1994). However, people with deficits in working or explicit memory appear to have lost the spontaneous ability to remember and correct their errors and so tend to repeat their mistakes. Ideally, therefore, people with memory impairments are thought to learn some tasks best under conditions where mistakes are minimised and unconscious hypothesis testing is precluded. In memory rehabilitation for example, there is substantial evidence that error-free learning - in which mistakes are minimised or eliminated during instruction - is a productive way forward in teaching some tasks to people with memory impairments, perhaps because this type of instruction lessens the load on working memory and prevents the build up of explicit knowledge about the task being learned. The error-free learning effect appears to be mediated by implicit memory processes: individuals with reduced explicit memory benefit from errorless learning because it by-passes the need to engage explicit error elimination processes. (Baddeley & Wilson, 1994, Evans et al., 2000; Hunkin, et al., 1998; Kessels & Haan, 2003; Maxwell et al., 2001; Todd & Barrow, 2008; Wilson et al., 1994). Error-free techniques appear to be particularly beneficial in the early stages of motor skill learning in normal learners (see Maxwell et al., 2008 for review). Skills learned in this way appear to be independent of age and natural ability, resistant to the negative effects of fatigue and secondary task loads, and transfer well to other task variations (Maxwell et al., 2008). Though the authors concede that considerable work is needed before definitive conclusions can be reached, this type of research challenges the received wisdom that motor skill learning must *necessarily* proceed from the explicit to the implicit and points to the conclusion that such learning can be achieved through relatively passive aggregation of action-outcome contingencies gained through simple exposure (Maxwell et al., 2001; Orrell et al., 2006; Poolton et al., 2005).

This study aims to build on the small body of evidence that early motor-skill acquisition may be optimised if verbal instruction is avoided as an adjunct to error-reduced learning (Poolton, et al., 2005,

Boyd & Winstein, 2004; Orrell, et al., 2006). It tests, for the first time, the applicability of instruction-free learning in physically able but memory-impaired people with a wide range of aetiologies. Participants were taught golf putting, using an error-reduced paradigm devised and validated by Maxwell et al. (2001), in which task difficulty is gradually increased so that the number of errors made during practice is minimised. One group received explicit task-related instructions (Orrell et al., 2006) between learning trials and the other group did not receive any instructions other than to 'do their best.'

The hypothesis of the study was that people with memory impairment would acquire the gross perceptual motor skill of golf putting less efficiently if they were given verbal instruction during the learning process. The study did not aim to replicate the results of previous research demonstrating that people with memory problems can acquire perceptual motor skills if taught under error-free conditions. Therefore no pre-post test comparisons of learning outcomes were carried out. The methodology of Maxwell et al. (2001), used here, aimed to reduce the overall number of errors during task acquisition by starting with 'easy' putts close to the hole and moving further away at each 50 putt trial. However, increases in the number of missed putts are to be expected as the task becomes more difficult and the resultant data does not therefore demonstrate the typical learning curve anticipated if, for example all 400 putts were taken from the same distance.

The objective of this study was to examine the pattern demonstrated by the number of successful putts at each hole, between groups. If an instruction-free method was effective the uninstructed group would show a higher number of successful putts at individual trials than the instructed group. Also the data may reveal at what stage, if any, in the skill acquisition process the effect of giving instructions, as observed in the present study, starts to affect performance.

## METHOD

### Design

Ten pairs of participants, matched by their similarity on scores in the Rivermead Behavioural Memory Test-11 (Wilson et al., 1991) were randomly assigned to one of two conditions (uninstructed and instructed) in a golf-putting task carried out under reduced-error conditions. The task involved seven blocks of learning trials at distances of 25, 50, 100, 125, 150 and 175 cms. consisting of 50 putts each. Data in the form of the number of successful putts in total, for each learning trial distance were analysed using a two-way (7) x 2 mixed design ANOVA. The within subjects factor was trial distance (25cm vs. 50cm vs. 75cm vs. 100cm vs. 125cm vs 150cm vs. 175cm) and the between subjects factor was group (uninstructed vs. instructed).

## Materials and apparatus

Apparatus: The same Slazenger Executive © practice golf putting mat and standard golf putter was used for all participants. Distances were marked with chalk lines across the mat at The centre of the line was marked with a cross to facilitate correct placing of the ball. A written sheet containing standardised explicit instructions and schedule for when the instructions were to be given was compiled for the researcher to use. Results were recorded on score sheets designed for the purpose (See sample score sheet at III). Qualitative data from the implicit learning group was also recorded on the relevant score sheets.

## Participants

Thirty attendees at The Brain and Spinal Injury Centre a registered charity in Salford, Greater Manchester replied to a letter sent out by the researcher expressing an interest in taking part in memory research. Six declared significant problems with mobility, weakness, balance or eyesight and were screened out at this stage. They were thanked for their response and offered the opportunity to take part in another memory research project not requiring physical fitness. Twenty-four participants were invited for further screening for perceptual motor ability, flexibility and agility, eyesight, general fitness and ability to comprehend instructions, using the tasks described below.<sup>2</sup> All claimed to be non-golfers. Participants were not timed on the screening tasks but were expected to complete them with 100 per cent accuracy.

*Perceptual-motor ability:* A counter sorting task, an adaptation of the ‘nuts and bolts sorting task,’ which has been used as an exercise for many years in cognitive rehabilitation (Novack, Berquist, Bennett & Hartley, 1987) was employed. Forty red and yellow counters were mixed and placed in a 16 x16 cms container and two similar sized empty containers were placed on either side of the one containing the counters at a distance of 10cms. The participants were required to simultaneously sort the yellow counters into the container on the left, using the left hand and the red counters into the right container using the right hand. This task is difficult for people with neglect or perceptual-motor problems.

*Agility and balance while moving.* An adaptation of the agility sub-test of the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) Functional Fitness Test battery (Osness, Adrian, Clark, Hoeger, Raab, & Wiswell, 1990) was used. Gandee, Knierim, Fox and Kadavy

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<sup>2</sup> At the time of this experiment there appeared to be no validated tests of perceptual motor ability or skill learning applicable to this group A skill learning component has since been added to the RBMT-3 (Wilson, Greenfield, Clare, Baddeley, Cockburn, Watson, Tate, Sopena & Nannery, 2008).

(1993) describe the AAHPERD tests - which are designed for older people with low physical fitness - as useful in providing feedback to establish the individual's functional status and compare motor skill level between individuals. This task involves the participant rising from a chair when instructed to do so and walking in a figure of eight pattern before returning to the chair, sitting down and then repeating the procedure. The timing element of the original test and marking of the route with cones was omitted.

*General fitness.* Participants completed the Canadian Society for Exercise Physiology's Physical Activity Readiness Questionnaire (PAR-Q) © (2002), which is used to screen the health status of people about to begin a fitness programme. (See Appendix IV).

*Eyesight:* The participants were asked to read the words '25cm', which was marked in chalk 25 cms away from the hole on the golfing mat, from a distance of 200 cms, with spectacles if worn.

On completion of the tests and questionnaire, four participants were screened out of the experimental group (two on inability to complete the counter-sorting task to criterion, one on the agility task due to inability to understand the instructions and one on the basis of a positive response to the question, 'Do you ever lose your balance due to dizziness' question on the Par-Q. They were given the opportunity to take part in further memory research which did not necessitate physical fitness. Participants were not excluded on the grounds of age. The rationale for this is that the results of a large scale lifespan study for acquisition of a gross motor task (juggling) did not show an incremental decline in older adults aged between 30 and 70 (Voelcker-Rehage & Willimczik, 2006; Voelcker-Rehage, 2008). Golf putting is a gross/low complexity motor skill and therefore it was assumed should show a similar pattern of motor learning as in the Voelcker-Rehage and Willimczik (2006) juggling study. Following screening, twenty participants (11 male and 9 female) with a mean age of 48.5, range: 29-74 (See Table 1) were selected to take part in the study. All have a brain injury or suffer from a neurological condition and report memory problems which have an impact on their daily lives. The participants were tested by the researcher using the RBMT-11 (Wilson et al., 1991) and given individual feedback on the results. The five participants whose profile scores fell into the normal range as laid down by the RBMT-11, but who nevertheless reported memory problems completed an Everyday Memory Questionnaire (Powell & Malia, 1999). These were included in the study. The memory skills questionnaire (Powell & Malia date, see Appendix VII) represents a subjective record of the everyday memory behaviour of the person completing the questionnaire with regard to typical everyday memory failures. The authors state that a



score of between 8 and 20 indicates the person completing the form may have a poor memory and may benefit from using compensatory strategies. Only the self scores were included in this study. Following scoring of the RBMT or MQS questionnaire all participants were given feedback and advice on strategies which may help their individual problems<sup>3</sup>. All participants were given feedback on the results of the RBMT or the questionnaire.

After screening, two groups of ten pairs were then randomly allocated to one of the two experimental conditions based on the similarity of their profile scores on the RBMT-11 (see Table 4.1 below). All participants gave their written informed consent and were given a typed explanation of the purpose of the experiment stating that it was designed to look at the best way in which people with memory problems can acquire new motor skill. They were told they could withdraw from the study at any time.

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<sup>3</sup> A substantial number of people with brain injuries complain of memory deficits, despite achieving scores within the normal range on tests of memory functioning (Wills, Clare, Shiel & Wilson, 2000). Since participants for this study were tested an extended version of the RBMT (the RBMTE) has become available which detects more subtle decrements in memory performance (Wilson, Clare, Baddeley, Cockburn, Watson, & Tate, 1999).

Table 4.1: Characteristics of participants paired by learning condition.

| Pp | Gender | Age | Injury/<br>condition | RBMT<br>profile score | Memory level | MQS<br>score | Learning<br>condition |
|----|--------|-----|----------------------|-----------------------|--------------|--------------|-----------------------|
| 1  | F      | 49  | SAH                  | 22                    | Normal       | 9            | Instruction           |
| 2  | F      | 57  | TBI                  | 23                    | Normal       | 9            | No instruction        |
| 3  | F      | 56  | Tumour               | 19                    | Poor         |              | Instruction           |
| 4  | F      | 38  | TBI                  | 16                    | Mod          |              | No instruction        |
| 5  | M      | 60  | SAH                  | 21                    | Poor         |              | Instruction           |
| 6  | M      | 74  | CVA                  | 19                    | Poor         |              | No instruction        |
| 7  | M      | 33  | SAH                  | 23                    | Normal       | 13           | Instruction           |
| 8  | M      | 54  | Cerebral Vasculitis  | 21                    | Poor         |              | No instruction        |
| 9  | M      | 33  | TBI                  | 14                    | Mod          |              | Instruction           |
| 10 | M      | 42  | Colloid cyst         | 19                    | Poor         |              | No instruction        |
| 11 | M      | 48  | TBI                  | 10                    | Mod          |              | Instruction           |
| 12 | F      | 44  | TBI                  | 9                     | Severe       |              | No instruction        |
| 13 | M      | 34  | Hydroceph            | 14                    | Mod          |              | Instruction           |
| 14 | M      | 35  | Enceph               | 12                    | Mod          |              | No Instruction        |
| 15 | F      | 52  | SAH                  | 17                    | Poor         |              | Instruction           |
| 16 | M      | 29  | TBI                  | 19                    | Poor         |              | No instruction        |
| 17 | F      | 52  | SAH                  | 20                    | Poor         |              | Instruction           |
| 18 | F      | 73  | CVA                  | 18                    | Poor         |              | No instruction        |
| 19 | M      | 69  | SAH                  | 22                    | Normal       | 11           | Instruction           |
| 20 | F      | 39  | Anoxia               | 23                    | Normal       | 15           | No instruction        |

Key: CVA = Cerebro-vascular accident (stroke), Hydroceph = hydrocephalus, TBI = traumatic brain injury, MS = Multiple Sclerosis, SAH = Sub-arachnoid haemorrhage, Enceph = Encephalitis.

## Procedure

Participants undertook the study individually in a quiet room at the Brain and Spinal Injury Centre in Salford, Greater Manchester. Before taking part they were reminded that they would be learning how to putt, and that the experimenter would collect the balls and place them where they needed to go. All were asked if they felt well, were told that they could request to sit down at any time, withdraw at any time and that there was no time limit. For both groups, errors were minimised by using a constrained environment (Maxwell et al., 2001), so that participants started very close to the hole (25cm). Following each block of 50 trials task difficulty was progressively increased by moving further from the hole in 25cm increments until a final putting distance of 175cm was achieved.

The instructed learning group was given standardised verbal instructions employed by Orrell et al. (2006), reproduced below, seven times: i.e. before starting and between each subsequent trial block. No additional information was supplied.

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### Explicit instructions

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1. Keep your feet shoulder width apart and knees slightly bent.
  2. Place your right hand below your left hand when gripping the club handle.
  3. Move the club back a short distance then swing the club forward with a smooth action along a straight line.
  4. Allow the club to continue swinging a short distance after contact with the ball.
  5. Adjust the speed of your movement so that the correct amount of force is applied.
  6. When you hit the ball make sure that the putter head is at a right angle to the direction you want the ball to travel.
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The uninstructed group participants were given no verbal instructions, but were told to ‘do their best to get the ball into the hole.’ The experimenter retrieved and replaced the balls onto the relevant distance marker throughout.

Data in the form of number of accurate putts out of 50 was collected following the learning trials and compared between the groups. Qualitative data in the form of comments about any ‘rules of the game,’ they may have acquired during the learning trials was collected from members of the implicit learning group.

## RESULTS

To explore whether performance changed across trial distance and groups a two-way (7) x 2 mixed design ANOVA was performed. The within subjects factor was trial distance (25cm vs. 50cm vs. 75cm vs. 100cm vs. 125cm vs 150cm vs. 175cm) and the between subjects factor was group (uninstructed vs. instructed). Mauchly's test indicated that the sphericity assumption was violated,  $W = .023$ ,  $\chi^2(20) = 59.60$ ,  $p < .001$ , and therefore Greenhouse-Geisser statistics are reported for within-subjects results. The ANOVA revealed a significant main effect of trial distance, Greenhouse-Geisser  $F(2.62, 47.16) = 30.97$ ,  $p < .001$ , but not of group  $F(1, 18) = 0.01$ ,  $p = .925$ , and there was no significant trial distance by group interaction, Greenhouse-Geisser  $F(2.62, 47.16) = .67$ ,  $p = .553$ . Importantly, there was also a significant quadratic trend,  $F(1, 18) = 37.82$ ,  $p < .001$ . Figure 4.1 depicts this trend, mean number of putts decreasing most steeply across distances 25cms to 75cms, less steeply across distances 75cms to 150 cms, and then increasing across distances 150 cms and 175 cms. Thus, as expected, in general, the putting performance of all participants gradually decreased as they moved further away from the hole, but the rate of decrease became less before a reversal occurred at the end, perhaps indicating the beginning of improvements in performance. This overall pattern was broadly reflected in the results of post hoc comparisons which were used to locate significant differences in means signalled by the significant main effect of trial distance. These comparisons used the Sidak method for adjustment and showed that compared to distances 25 and 50 cms all later distances resulted in fewer successful putts ( $p$  at least  $< .05$  in all cases), the same was also largely true of distance 75 cms (here, distances 125, 150 and 175 resulted in fewer successful putts –  $p$  at least  $< .05$ , but distance 100cms did not –  $p = .562$ ). However, from 100 cms onwards, while for the most part the number of successful putts continued to fall in later blocks, these differences were non-significant ( $p > .05$  in all cases). The only exception to this pattern was that distance 175 cms resulted in *more* successful putts than block 6, but this reversal was non-significant ( $p = .567$ ).

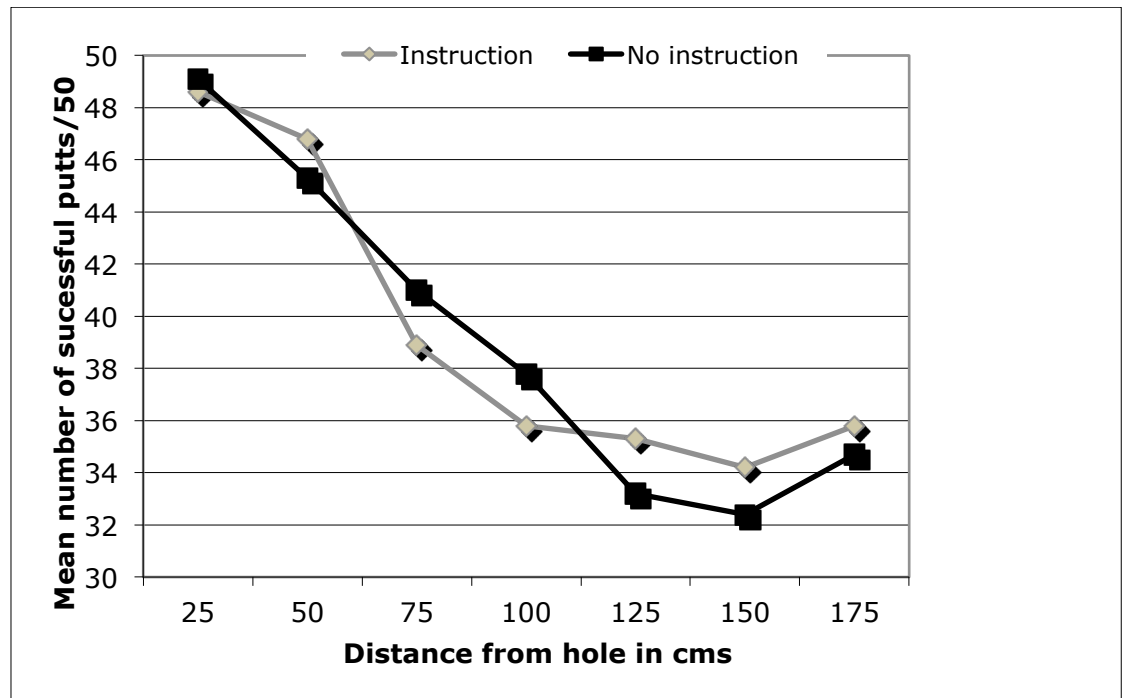


Fig 4.1 Mean number of successful putts out of 50 by participants in the instruction and no-instruction groups, demonstrating a quadratic trend.

On the basis of these results  $H_0$  is not rejected : there is no significant difference between in the insructed and unistructed groups in terms of score achievement. There was no significant trial distance by group interaction. Therefore the hypothesis that giving explicit instructions would adversely affect of the acquisition of the gross perceptual motor task of golf putting is not supported in this study.

Following the golf putting trials, those in the no instruction condition were asked to comment on any 'rules of the game' learned during the experience. Eight out of ten participants gave their views. A mean of 5 rules were suggested (range 3-8). Two declined, saying they had 'just got on with it.' Below (Table 4.3) enumerates the rules formulated spontaneously by the uninstructed participants.

Table 4.2 Comments on the 'rules of golf' made by participants in the no instruction learning group.

| Pp. - Condition           | Comments on the 'rules of golf'  |
|---------------------------|--|
| Pp 1 TBI                  | <p>I was thinking how hard to hit the ball.</p> <p>A little tap at first, then harder – learning as you go along.</p> <p>You need to look at the distance and focus on a little swing or a hard tap.</p> <p>I did not think about how to hold the club, but I hit the ball towards the middle of the club head.</p> <p>Keep the club head facing the hole</p>  |
| Pp. 2 TBI                 | <p>It works better the closer to the shaft you hit the ball – the straighter it is likely to be.</p> <p>Thinking about how hard you are meant to be hitting it, adjusting how hard you hit it.</p> <p>You are doing it without thinking about it. There's a nice spatial sense.</p>  |
| Pp. 3 Colloid Cyst        | <p>The motion of swinging the arms. Get the angle and swing it right.</p> <p>The amount of pressure on the ball.</p> <p>As I went up the green my head was getting tired and it was harder. I took the swing too quickly. I wasn't concentrating. If I went at a medium pace I was OK. If I went too quick I was missing the hole.</p> <p>I have watched golfers on TV so I took their position, it was natural. I've never played.</p> <p>That's the closest I've ever come to a green.</p> |
| Pp. 4 Cerebral Vasculitis | <p>Because I got tired my concentration was lapsing.</p> <p>I could tell before I hit the ball that my concentration was going.</p> <p>Didn't find the distance made any difference to my performance. My technique didn't change.</p> <p>When I was concentrating the angle and the position was right for the ball to go in. I almost knew when it was going to go in.</p>   |
| Pp. 5 CVA                 | <p>I tried to do it better.</p> <p>I put the putter in the right place, right up to the ball.</p> <p>You've got to slow the force down – not hit too hard.</p> <p>Stand with your legs apart to get the right balance.</p> <p>I've seen them do it on TV and I consciously used that stance.</p> <p>I need more practice. I need to practice my co-ordination.</p>   |
| Pp. 6 TBI                 | <p>The ball has to be hit straight on.</p> <p>You try to hit the ball in the middle of the putter, but end up going off to one side.</p> <p>I stood how I've seen golfers stand on TV.</p>   |
| Pp. 7 Anoxia              | <p>It's better if I don't think about it.</p> <p>Put the ball just below where the stick goes into the head of the putter.</p> <p>Had to align it straight on.</p> <p>My rhythm when I concentrate goes wrong.</p>   |
| Pp. 8 CVA                 | <p>The angle of the stick – I just realised that's important.</p> <p>Knowing the weight of the hit – how hard you have to hit it. The answer's about the middle.</p> <p>I knew when the ball was going to go in.</p> <p>I was trying consciously to balance the head so it was straight.</p> <p>I watch a lot of golf on TV and possibly know how to stand from that.</p>  |

The results show that eight participants in the uninstructed group were able to state some of the rules of the putting game showing evidence of explicit learning from their experience during practice. These rules were similar to the verbal instructions received by the instructed group apart from instruction 4: “Allow the club to continue swinging a short distance after contact with the ball,” which did not have an equivalent. Four out of eight said they had learned how to stand through watching golfers on television. All eight participants commented on the importance of where to position the putter head in relation to the ball, for example: “The ball has to be hit straight on. You try to hit the ball with the middle of it [the putter] but you end up going off to one side”; “Put the ball just below where the stick goes [into the putter head]. Had to align straight on,” and “The angle of the stick - I just realised that’s important... hit it about the middle and I knew when the ball was going in. I was trying to adjust it consciously - trying to balance the head so it was straight.” There were contradictory comments about the need for concentration during the task: “You are doing it without thinking about it - nice spatial sense,” and, “It was better if I didn’t think about it. My rhythm when I concentrate goes wrong,” as opposed to, “If I went too quick I wasn’t concentrating and I was missing the hole,” and “My concentration lapsed because I was getting tired. I could tell before I hit the ball that my concentration was going.”

## DISCUSSION

On the basis of the results of this study the hypothesis that giving explicit instructions to people with memory impairment during the acquisition of a perceptual motor skill would inhibit performance is not supported. No statistically significant difference or interaction between instructed and uninstructed groups were detected. One inference, however, which can be drawn from the results is that, in the current sample, the instruction-free protocol applied to motor-skill acquisition was comparable to learning which involves explicit instruction, with the important caveat that error-free conditions are applied. Had the proposition been that giving explicit instructions when teaching someone a new skill is no better or worse than ‘letting them get on with it,’ a null result such as this would be encouraging as it would suggest that both ways of learning are effective. This is potentially useful information for rehabilitation professionals, because, while not suggesting that explicit instructions interfere with implicit learning, it may imply that such instructions are superfluous and can be safely avoided as long as error-free conditions are maintained.

In this study errors were restricted artificially by the method employed by Maxwell et al. (2001) of beginning putting practice very close to the hole and gradually increasing distance from the hole. Despite the variation in memory status and their differing aetiologies and ages, error-free learning appeared to be successful here for both groups, though, as mentioned above, the methodology did not lend itself to demonstrating a normal learning curve. Because the method used resulted in lower scores as the trials progressed (until the final trial) it is difficult to assess if *learning* was taking place. However the reversal which occurred between the final two holes in both groups could perhaps indicate the beginnings of stability in expertise which, in motor learning tasks, comes before a ceiling in performance is reached (Hauptmann et al., 2005). Participants' scores compared well with those of four non memory-impaired participants in a pilot study also carried out using the same methodology (See Appendix I). This is unsurprising given the mounting evidence that error-reduction is a key variable in the initial stages of acquisition of highly proceduralised tasks for people with moderate to severe explicit memory difficulty (Hauptmann et al., 2005). Given this research base, it seems reasonable to extrapolate that in this study the robust effect of error reduction overshadowed any influence of the instruction-free paradigm. Had errors not been constrained it is possible that an effect would be shown between the two groups. Added to this is the manner in which the instructions were given. For purposes of standardisation, the same set of instructions was read out loud by the researcher during the pauses between trials. Advice was not given simultaneously with the task and neither did the instructions relate to the actual performance of the individual, as would be the case during naturalistic teaching. Instructions repeated 'parrot fashion,' in this way may be ignored by the learner, heard but not attended to, or perceived as irrelevant. The most parsimonious explanation, therefore, for the lack of effect is that both groups learned implicitly. Error-free conditions were robust enough to suppress explicit hypothesis testing and rendered the instructions superfluous.

There are, of course, other explanations for the lack of effect, not least the small number of participants, leading to a lack of statistical power. Thirty participants were recruited, as indicated by the power calculation which preceded this study, but in practice ten were eliminated because of subtle health problems not apparent before screening, reflecting the difficulties in obtaining larger sample sizes from this group of participants for this category of task.

Perhaps the most interesting outcome is that eight out of ten participants in the uninstructed learning group spontaneously recalled a majority of self-generated explicit 'rules' of the game engendered during practice, and that these resembled the instructions given to the instructed group. Some of the rules were detailed and considered, apparently demonstrating explicit learning from an implicit task. Implicit learning in people with amnesia is characterised by a lack of recall of the learning process, but this is not necessarily the case in other learners. That lack of recall was not evident in this study replicated the findings of Poolton et al. (2005) in which normal learners in an implicit (errorless) golf-putting task recalled nearly as many explicit rules of the game as those in the explicit (errorful)



condition. It is argued here that poorer remembrance of the learning process may have been demonstrated had the learners been restricted to those with severe memory impairments. One of the two members of the uninstructed group who declined the opportunity to comment on what he had learned did have severe memory problems as a result of encephalitis (the other, a sub-arachnoid haemorrhage patient, had memory scores in the normal range). All participants in this study reported explicit memory problems, but for the majority, their residual explicit memory may have been sufficient to support some new explicit learning. Additionally, some knowledge of golf may have been retrieved from long-term memory, for while none had played the game, four out of eight implicit learners reported copying what they had seen on television.

This study faces limitations. In retrospect the task was too physically demanding to allow for a more sizeable participant group to be recruited, given the resources of the researcher and arguably, the skill acquisition process did not continue for long enough. A less arduous task would extend the potential experimental group to include those people with brain injury who are less physically able. The effort involved in completing the learning phase mitigated against carrying out follow-up retention tests at longer intervals which may have been useful to test the comparative robustness of the learning groups over time. It is not just how well a task is learned, but how it stands up to the passage of time which is important when decisions are being made as to how it should be taught. This needs further investigation. It is evident that more work needs to be done on the effectiveness or otherwise of giving instructions during skill-acquisition. However for purposes of ecological validity the tasks need to be useful and interesting to the participant. Ideally the instructions need to be individualised, relevant to the actual performance of the individual as the task proceeds – a process which is difficult to standardise.

Instruction is central to the rehabilitation of people with neurological impairments, who must re-learn lost skills and acquire new ones in order to live adaptively. Yet effective instruction for this group of people is challenging and requires specialised instruction techniques (Sohlberg & Turkstra, 2011), some of which may be counter-intuitive (e.g. error-free learning runs contrary to the common lay belief that you learn by your mistakes). Error-reduction is proving its worth in skill learning and other areas, however more work is needed to extend the research base on effective instruction methods. Many useful skills involving motoric sequences do not lend themselves easily to error-free techniques and it is suggested here that one area for future work could be aimed at identifying such tasks and demonstrating whether or not in these cases instruction-free learning may provide a practical alternative to error-reduction. A taxonomy of such tasks may include those used by physiotherapists in rehabilitation, such as teaching the use of specialist equipment to improve posture, balance and hand grip in stroke and other head-injured patients. Other pastimes aimed at hand-eye co-ordination, or general fitness, or improving social skills, which may prove amenable to instruction-free paradigms could include

learning to play ball games, or games such as snooker or darts. In each case it may be necessary to know when to tell the learner what to do, and when to keep quiet.

## CHAPTER FIVE

*5.1 It's not what you say, it's the way that you say it: Using conversational cues to enhance episodic recall of a Laurel and Hardy film clip in people with memory difficulties.*

### INTRODUCTION

The two studies reported above examine the optimisation of implicit memory to help people with memory difficulties acquire useful skills for work and everyday life. This study looks at a completely different aspect of their lives. It addresses a seemingly intractable problem which nevertheless is what people with memory problems arguably want most: to be able to spontaneously remember the detail of recent events. What links these seemingly incongruent abilities is the contribution of implicit memory, which in addition to mediating skill learning, has been shown in laboratory work to underlie the phenomena of cueing and priming. The proposition under scrutiny in this study is whether these experimental findings can be optimised to enhance recall in everyday conversation.

A classic symptom of memory damage caused through brain injury is a reduced ability to recall the recent past. At its worst this impairment of anterograde episodic memory can leave victims stranded in time, powerless to up-date the narrative of their lives. In everyday social interaction, contemporaneous conversation soon dries up, and the same few well-remembered tales, resurrected intact from retrograde memory, are endlessly repeated. Their exasperated friends and relatives, would like to help those with memory impairments remember more about their experiences, but at the time this research was embarked upon little guidance was available on how this could be achieved.

Being able to recall more of our recent experiences has wider implications than the obvious one of providing the type of satisfying conversation those with uninjured memory take for granted. Many of our interactions with others involve the ability to tell coherent stories of our personal experience. Such conversations are crucial for a variety of social and psychological functions (Edwards, 1997; Norrick, 2000; Ochs & Capps, 2001). They give structure to experiences and memories, and help people to make sense of the world (Bruner, 2001). However, in anterograde memory impairment, the process is disrupted. People affected can no longer rely on their brain's ability to fulfil these tasks (Medved, 2007).

In a micro-analytic study Medved (2007) used personal narratives of people with organic memory problems of differing aetiologies, to identify the strategies they used to make up for their lack of event memory, starkly illustrating the struggles of this group of people to fill the gaps in their

knowledge and appear normal in conversation. These strategies included ‘memory importation’ - transplanting a past memory into the present; appropriation of others’ memories and passing them off as their own, and memory compensation, the efforts of the rememberer to “cobble vague memory pieces together” (Medved, 2007 p. 611). Medved’s (2007) study has interesting observations to make about the approach and questioning style of the conversation partners who had no brain injury. When the memory-impaired participants used the various strategies described above, the listeners’ expectations of a normal conversation were not met, so that they often halted, ‘interrogated’ the person being interviewed or ignored what was being recounted, “thus insinuating that the narrative might be the result of confusion, confabulation and the like,” and implying that the accounts were “problematic, improbable or odd” (Medved, 2007 p. 613). The Medved (2007) study was not intended as an attempt to improve the participants’ recall, but was a detailed and careful investigation of the ways in which those with anterograde memory difficulty unconsciously strive to cover up their lack of recent memory. However, it is contended here, that it raises the possibility that an alternative approach, using different types of questions and verbal interactions on the part of the listener could have helped to augment recall in those with memory problems, obviating the need for them to resort to the rather desperate, compensations identified by Medved (2007) and which are all too recognisable to those working with this group of people.

The possibility that the way people with memory problems are addressed in conversation may aid recall, and the initial motivation for the present study, arose from an observation cited by Wilson (1987) who suggested nearly thirty years ago that it might be helpful to teach relatives to phrase questions in a specific manner in order to enhance retrieval. She quoted a patient who, when asked, ‘Do you remember who came to see you yesterday and where you went?’ replied, ‘No.’ Yet when the question was rephrased as, ‘When Roy came yesterday, where did he take you?’ she answered, ‘To the theatre.’ (Wilson, 1987 p. 59). Baddeley (1982) also has suggested that getting memory-impaired people to reveal what they know depends on how they are asked. Though not stated explicitly by either Wilson or Baddeley, the implication, as interpreted in the study reported in this work, is that asking open-ended questions, rather than closed questions such as ‘Do you remember?’ which demand a yes/no or forced choice answer, may act as more effective cues to recall in those with memory impairments: though the cognitive underpinnings of this phenomenon are not clear.

While cueing of various types has been extensively investigated in the laboratory (e.g. Warrington & Weiskrantz, 1974; Mayes & Meudell, 1981), prior to this study, there appears to be no published work on the use of open questions as cues in people with memory impairments. This work explores the suggestion that disparate classifications of verbal cues may be differentially effective in promoting recall and offers tentative explanations as to why this might be the case. It also examines the effect of what are mooted to be unconscious cues, which arise from the peripheral environment of the experienced episode, indirectly benefiting memory for information recalled in the reinstated context

(Smith, 1988; Smith & Vela, 2001). It is suggested that this effect can be engendered through the technique of imaginal context-reinstatement in which the participant is encouraged to imagine the thoughts and feelings as well as the physical circumstances in which encoding took place (Godden & Baddeley, 1975; Smith et al., 1978; Smith, 1988). Imaginal context-reinstatement has been shown to be effective in some populations (see Smith & Vela, 2001 for review), but appears, from a search of the literature, not to have been tested in people with organic memory damage. The eventual aim is to offer conversational guidelines for relatives and friends of those with memory impairment.

### **Cueing and priming**

In normal memory, it is well established in the laboratory that cueing increases the accessibility of information at recall and is differentially effective depending on the type of cue given (Tulving & Thomson, 1973). It appears that both traces of past experience and cues established in the cognitive system are critical determinants of remembering (Reidinger & Guynn, 1996). People with amnesia too respond to certain types of cueing in the laboratory (e.g. Mayes & Meudell, 1981; Warrington & Weiskrantz, 1974;) and priming (e.g. Graf & Mandler, 1984; Yaniv, Myer & Davidson, 1995), implying that memory-impaired people encode more information than they realise but, in the absence of external cues, lack the means to spontaneously extract it. In Tulving and Thomson's (1973) terms it is available but not accessible. Experimentally cueing has been shown to be effective in amnesia arising from various types of injury. For example, it appears that in those with memory damage the ability to retrieve words cued by their first three letters is relatively normal while verbal recognition memory is very poor (Warrington & Weiskrantz, 1974). Miller (1975) also demonstrated effective cueing in people with, what was then described as pre-senile dementia, while a similar effect has been shown in people who had received electro-convulsive therapy, known to have a detrimental effect on memory (Squire, Wetzel & Slater, 1978).

These findings appear to support the proposition that the memory problems in amnesia do not entirely arise from acquisition or retention failures, but a selective deficit of retrieval may be operating. This may have its roots in interference (Mayes & Meudell, 1981) and it is thought that cueing may function by limiting the number of possible correct responses, thus reducing interference from competing similar items in memory. In cueing experiments, the cued scores can be comparable in amnesics and participants with normal memory, but the results differ qualitatively because although amnesics may 'get it right' they frequently feel themselves to be guessing (Mayes & Meudell, 1981). This type of unconscious recall is assumed to function through the priming mechanism - a non-conscious influence of past experience on current performance or behaviour (Schacter & Buckner, 1998) - which is thought to remain intact after damage to explicit memory.

Priming refers to the improvement in detecting or identifying a stimulus based purely on recent exposure. A person primed in this way may not realise he or she is 'remembering' but rather

assume a correct response is a lucky guess (Hamann et al., 1995). Priming is thought to be one element of a dissociable implicit memory system, which is mediated through brain areas which are not involved in explicit recall and are relatively resistant to brain injury pathology. However, studies using people with amnesia carried out in the 1980s found that successful priming of word stems depended crucially on the instructions given to the participants. When instructed to produce the correct word from a study list, people with amnesia showed poorer recall than controls. However when they were asked to respond with 'the first word that comes to mind,' they showed normal recall (Graf, Squire & Mandler, 1984).

The most influential explanation for what makes an effective cue lies in Tulving's encoding specificity hypothesis (Thomson & Tulving, 1970; Tulving & Pearlstone, 1966; Tulving & Osler, 1968; Tulving & Thomson, 1973), predicated on the idea that what is remembered depends on the similarity of memory traces formed during encoding and the memory probes used at retrieval. Overlap between the two sets of conditions appears to be involved in successfully converting a potential memory into conscious awareness. Failure to retrieve an item from episodic memory does not necessarily indicate that the corresponding information has been lost from memory, or that it was never encoded. It may be that the information is available, but not currently accessible. Cueing increases the accessibility of the information and is differentially effective depending on the type of cue given (Tulving & Thomson, 1973). Tulving and Thomson's (1973) work using participants with normal memory showed successful cued recall of word pairs depended on the word-cue used at retrieval being present at encoding. Weak associates of words which were present in the original list as cues (e.g. glue - chair) resulted in better recall than associated cues which were stronger, but which were present only during the recall stage (e.g. table - chair). Cues presented during encoding, reproduced at recall, produced better scores. However all types of cueing improved performance in normal memory compared with free recall (Tulving & Osler, 1968). There appears no doubt that congruence between cues present at encoding and retrieval is a powerful aid to recall, at least for those with normal memory.

The work described above refers to laboratory work using predominantly word lists. There appears to be no published work on cueing and amnesia which uses an ecologically valid paradigm apart from, arguably, the method of 'vanishing cues' which is used in rehabilitation to teach vocabulary (e.g., Glisky et al 1986a, 1986b). This method, which uses first a whole word, then progressively fewer letters of the word as cues, capitalises on the ability of people with amnesia to respond to the priming of words in stem completion tasks, as demonstrated in research on direct priming (Cermak et al., 1985; Diamond & Rozin, 1984; Graf & Mandler, 1984; Graf & Schacter, 1985; Schacter, 1985; Warrington & Weiskrantz, 1974). However, some limited backing for the hypothesis that open-ended questions may be effective as cues during longer verbal interactions comes from research in forensic psychology, across a spectrum of populations, using a technique known as the cognitive interview, developed originally for use by police detectives to improve accuracy in eye-witness testimony (Fisher, Geiselman & Amador, 1989; Geiselman, Fisher, MacKinnon & Holland 1985; Geiselman, Fisher,

MacKinnon & Holland, 1986; Memon & Koehnken, 1992; Memon, 1996; Wright & Holliday, 2007). Developmental work on the cognitive interview revealed that a recurring error made by ineffective interviewers was to ask too many closed questions (Fisher, 1986; Fisher & Guiselman, 1992). Accordingly, as one small part of an extensive package of techniques, cognitive interviewers are trained to let open questions predominate. The cognitive interview is a complex procedure, employing a combination of methods based on memory theory and communication techniques aimed at building rapport, which work in tandem. There have been a few attempts to isolate which of the components of the cognitive interview work best (see Memon & Higham, 1999, for review) but none of these included testing the isolated effects of asking different types of questions. The cognitive interview has never been envisaged or researched in terms of enhancing recall for people with memory problems, focusing rather on accuracy, which is of prime importance in a legal setting. However, Memon (personal communication, 2007), who has carried out extensive research in the field, felt that while other components of the cognitive interview may be too complex or confusing for participants with brain injury, asking open questions may be beneficial.

### **Imaginal context reinstatement**

If questions are to be asked during a conversation, they must be based on something. Initially this is likely to be what has been said in the free-recall of the person recounting the story. Therefore if free recall can be enhanced, the probability is that more questions will arise presenting the opportunity for more cues to be given in the form of questions. One recognised way of boosting free recall is the technique of imaginal context reinstatement in which the participant is instructed to mentally reconstruct the external environment and internal thoughts and feelings about the witnessed event during free recall (see Smith & Vela, 2001 for review). It has been suggested that imaginal context reinstatement is the most effective component of the cognitive interview (Memon & Higham, 1999) predicated on the finding in other work that recall is enhanced if the environmental context along with the thoughts and feelings of the rememberer present at the original learning is reinstated at recall (Godden & Baddeley, 1975; Smith et al., 1978; Smith, 1988). This type of context is defined by Smith (1988, p 29) as “information which is processed outside the focus of attention.” Such cues relating for example, to the environment such as the way the room looks, are assumed to be encoded unconsciously in memory traces and therefore should act as natural cues, indirectly benefiting memory for information recalled in the reinstated context. This explains why revisiting a place can aid memory for what happened there, or why we fail to remember who someone is when he or she is encountered in an unfamiliar context (Smith & Vela, 2001).

Experimentally, external context-setting is done either physically, by returning participants to the original place of learning, or mentally, by encouraging participants to imagine the mental and physical environment, present at the time of encoding. Godden and Baddeley (1975) convincingly

demonstrated the physical context reinstatement effect when their participants, scuba divers who recalled lists of words learned either under water or on dry land, fared better when there was congruence between the circumstances of learning and recall. Subsequent studies have shown similar effects using imaginal context reinstatement (e.g., Fernandez & Alonso, 2001). On the other hand some researchers have failed to find effects of environmental context on recall or, when they are found, context effects are small or statistically insignificant. Fernandez and Glenberg (1985) for example, found no effect of context in a series of experiments in which rooms were changed or kept constant between study and recall. It appears that in some cases learning and remembering are greatly affected by the background environment and in others it has much less influence. Attempting to explain this discrepancy, Smith and Vela (2001) examined the effect size of 83 varied external context reinstatement studies involving recall of word lists carried out between 1935 and 1997. Overall their meta-analysis supported the reliability of context effects, though, only ten of the reported experiments involved imaginal context reinstatement and none involved memory-impaired participants. Smith and Vela (2001) postulate that when environmental context reinstatement fails to enhance memory there are two possible explanations: the ‘overshadowing hypothesis,’ (e.g., Matzel, Schachtman & Miller, 1985), which proposes that little or no encoding of the environmental context has taken place because the high conceptual processing demands of the material to be remembered overshadow and suppress contextual cues. Smith and Vela (2001), state that this is more likely when the material is presented visually, for example on a computer screen. Another explanation is the ‘outshining hypothesis,’ (e.g., Smith, 1988, 1994), which has been described by different authors in similar ways (e.g. Eich, 1980; Geiselman & Bjork, 1980; Smith et al., 1978; Nixon and Kanak, 1985). The outshining principle states that contextual cues have been encoded but may not need to be used by the rememberer. This happens when cues are introduced relating to the test material which ‘outshine’ the effect of contextual cues, providing an explanation for why context reinstatement is apparently effective in free recall, where no cues are presented, but less so in cued recall (Fernandez & Glenberg, 1985).

Participants’ age is also suggested as an influence on the effectiveness of context reinstatement. It has been hypothesised that since elderly people have shown poorer episodic memory performance than younger people in a wide variety of tasks (Poon, 1985), they would be more likely to employ environmental context cues at recall because of poorer episodic memory for the test material. Testing this assumption with older and younger participants, Fernandez and Alonso (2001) found that old, but not young, participants’ free recall of long lists of words benefited from using the same room at encoding and test or from instructions to mentally reinstate the learning context. The authors postulate that these results are broadly consistent with the outshining hypothesis (e.g., Smith 1988, 1994; Smith and Vela, 2001) which assumes that external contextual cues have a relative value at retrieval, being most effective when no better alternative cues are available from the learned material. These results imply that if the performance of older people is attributable to poor episodic memory, environmental



context setting may benefit those whose memory difficulties are due to brain injury. However there are problems with this supposition. Fernandez and Alonzo (2001) did not perform memory tests on their participants and proceeded on the assumption that older people's episodic memory is necessarily poorer because of their age. The authors do not rule out other explanations for the results, such as the type of experimental material used. They cite experiments on memory for actions (Phillips & Kausler, 1992) and line drawings (Earles, Smith & Park, 1996) using young and old participants, which have shown no effect of context for either group. The suggestion is that the nature of the learning activities could have led to richer encoding cues available from the learned material, which could be used effectively at recall by both groups of participants, obviating the need for context cues to be employed. However, in cognitive interview research, the 'learning activity,' - usually the viewing of a real or filmed event - involves very rich encoding cues resulting from viewing a dynamic sequence of events including speech and actions, yet imaginal context reinstatement is invariably employed and is cited as the prime factor credited with helping to improve the number of accurate details reported (Milne & Bull, 2002).

### **Focal context**

It is contended here that open questions and prompts, particularly those which function by directing the rememberer back to the original material, may help to reinstate the focal context of what is being remembered and thus aid recall. Focal context is inherent in the material to be remembered, is consciously encoded and uses conscious awareness as a major retrieval strategy (Smith & Vela, 2001). In this it contrasts with environmental context - the type which is manipulated in the context reinstatement studies referred to above - which is incidentally encoded, is unrelated to the material which is to be recalled, and operates unconsciously at retrieval. Explaining the difference between the two, Smith and Vela (2001) make an analogy between foveal and peripheral vision where focal information is likened to foveal vision and environmental context information is compared with peripheral vision.

It could be hypothesised that the difference between the two types of context is related to attentional capacity. If the total amount of attentional capacity deployed at any one time is fixed (Kahneman, 1973), a demanding task takes attentional resources away from a less demanding task and when the supply of attention fails to meet demand, performance falters or fails. Processing complex visual material could arguably make such heavy demands on attention for people with brain injury, who are prone to attentional difficulty, that there is a very limited amount of attention left to process environmental context cues, producing a similar effect to the 'outshining' paradigm proposed by Smith (1988) and Smith and Vela (2001). Attention is also assumed to play a part in identifying which pieces of information are passed into long term memory. All information, from whatever modality, must first be taken in and processed, initially by some kind of cognitive mechanism which sorts the relevant from the irrelevant and what needs to be recalled from what is unnecessary. Only a tiny fraction of these

impressions are passed into long-term memory and just a small proportion of these are later retrievable (Mayes & Montaldi, 1999). Crucially these impressions, which are fast moving, complex, multi-modal and highly variable must not only be sorted, but also somehow linked together to form a coherent whole. One way of theorising how this intake system works is Baddeley's conceptualisation of working memory (Baddeley & Logie, 1999), a system comprising a central executive component capable of switching and controlling attention but which does not itself possess the capacity to store information. Subservient to the central executive are two so-called slave systems - the visuo-spatial sketch-pad and the phonological loop - dealing with visual and phonological material (Baddeley, 1986) and a third component, the episodic buffer, (Baddeley, 2000) which allows information from the different slave systems to be integrated and linked to long term memory. The idea of the episodic buffer provides one explanation for how information is bound together spatially and temporally to form an episodic memory. The buffer is assumed to be controlled by the central executive, to have a limited capacity because of the computational demands placed upon it and to use conscious awareness as a major retrieval strategy. Some people with amnesia have demonstrated normal recall of a prose passage in immediate free recall to an extent beyond the capacity of the phonological loop in short-term working memory (Baddeley & Wilson, 2002). These results appear to demonstrate the capability of the episodic buffer to temporarily activate representations in long term memory even when there is organic memory damage, but apparently only when executive functions are spared, pointing to the role of the frontal lobes in integrating new information (Baddeley & Wilson, 2002).

### **Active listening and 'reflecting back'**

A component of the cognitive interview, classified as is 'active listening' is a communication technique aimed at improving inter-interpersonal communication which is used across disciplines from crisis counselling to Alzheimer's care (see Weger, Castle & Emmett, 2010 for review). Active listening, used to demonstrate empathy, is the cornerstone of humanistic psychology (Rogers, 1942) and is employed extensively in therapy. A common element of most descriptions of active listening, is the idea of 'reflecting back' which refers to the process in which an interviewer - or more usually a counsellor - summarises what has been said by the interviewee, without contradiction or providing additional information, then asks for further elaboration. Weger et al. (2010) isolated the reflecting back element of active listening and applied it in the non-therapeutic setting of interviewing students about their course. They found that paraphrasing the words of the participant increased perceptions of the social attractiveness of the interviewer, conceptualised as the belief that he or she would be pleasant to spend time with. No work appears to have been done on the effectiveness of reflecting back as a memory enhancement technique for those with memory impairments and, based on the findings of Weger et al. (2010) it is difficult to argue from a cognitive perspective that a person unable to process

memories because of organic memory damage would recall more just because he or she finds the interviewer socially attractive. However it is suggested in this work that reflecting back - in the sense of repeating, paraphrasing or summarising the words of the participant - may have some effect on recall because it represents a type of open question or probe that can be used to repeatedly redirect the participant back to the material he or she is attempting to remember. Repeated attempts at remembering have been shown to result in more recall, as documented in work on phenomena such as retrieval practice, hypermnnesia and the reminiscence effect.

### **Retrieval Practice, hypermnnesia and the reminiscence effect**

For those with normal memory recalling information immediately it has been encountered and then at spaced intervals, can be more effective as a mnemonic than being re-presented with the original material and there is some evidence that this may occur in people with amnesia (Schacter, Rich & Stamp, 1985). Retrieval practice has also been found to be effective in the first published study of people with neurologically based memory difficulty, using participants with multiple sclerosis (Sumowski et al., 2010), demonstrating a strong advantage of retrieval practice over restudy for at least some people with memory impairments. Multiple attempts at retrieval have been shown to enhance recall when spaced in time, for example three attempts over three weeks when used with older adults (Dornburg & McDaniel, 2006). According to Bjork (1988), the more that is brought to mind in an initial attempt at retrieval, the more likely the information is to be recalled in the future and once information has been retrieved it becomes more readily available for subsequent retrievals. A critical aspect of the preservation of knowledge is maintaining access to that information in memory and the key to retrieving an item from memory is to use that information by revisiting it (Bjork, 1988). In everyday life, according to Bjork, (1988, p. 398) “every time we ask someone to tell us a name or number that might be retrievable from our memory, we rob ourselves of a learning opportunity.” In fact, Bjork (1975) argues, deeper, more difficult retrieval processes reactivate or strengthen encodings of an item making the memory more durable, less susceptible to interference and more supportive of long term retention. More recently brain-imaging research has provided converging evidence that the process of remembering an episode involves literally returning to the brain state present at the encoding of an episode (see Dunker & Anderson, 2010 for review). It appears that, in those with normal memory at least, the brain areas activated during episodic encoding are reactivated during retrieval: more reactivation occurs when more information is retrieved and reactivation occurs more strongly when more retrievals are made (Dunker & Anderson, 2010). According to some researchers, (Cabeza, Prince, Daselaar, Greenberg, Budde, Dolcos, LaBar & Rubin, 2004) this effect is more marked when the retrieval is of a real-life event than in laboratory work which is hypothesised to be because real life events provide a richer encoding context, resulting in more visual details being retrieved

It is accepted that a single attempt at recall in a memory test does not truly reflect memory

ability. The same test repeated a few minutes later will result in a different pattern of recall, sometimes less and sometimes more, but often different events will be brought to mind. Hypermnnesia, the phenomenon in which recall increases with increased retention intervals; and the reminiscence effect - in which previously 'forgotten' items are brought to mind - first explored by Ballard (1913), have been demonstrated numerous times (see Payne, 1987 for review). Apparently pictures and longer retention periods are more likely to bring about hypermnnesia. Erdelyi and Becker (1974) for example found 27% of previously unrecalled pictures were recalled at a second test. Madigan (1976) also concluded that it seems possible to increase amounts recalled by instructions that encourage subjects to continue or renew attempts at recall, as implied in other work (Borges, 1972; Ritter & Buschke, 1974).

### **Neuropsychological and cognitive issues**

From a cognitive perspective episodic memory has been said to involve the encoding, consolidation and recall of a sequence of linked scenes over a short period of time, from the observer's viewpoint, in which visual information is most likely to be most salient. The episode is likely to be interpreted in terms of available semantic knowledge and may be coloured by emotion (Mayes & Roberts, 2001). A major feature of episodic memory is the ability to associate very different types of information, for example perceptual, semantic, locations in space, temporal order and the relationship of various features to each other. The amount of attention deployed may determine which aspects are successfully encoded into memory. Successful retrieval of encoded items is postulated to be dependent on the rememberer engaging 'retrieval mode' (REMO), a mental set in which the cognitive system anticipates and is primed for episodic recall (Tulving, 1983). REMO is considered to be a pivotal, necessary condition for remembering past experiences (Lepage, Ghaffar, Nyberg & Tulving, 2000) and is marked by the focusing in of attention on the episode which is to be remembered. REMO is thought to guide processes such as 'ecphory' - the recovery of stored information. Conway (2002) has hypothesised that when in retrieval mode a portion of the past can be held in mind while the brain refrains from other types of processing which are not relevant to recalling the episode.

Episodes are multifaceted and highly variable and are based on complex patterns of neural activity in sites in the posterior neo-cortex that represent meaningfully interpreted as well as relatively uninterpreted sensory information (Montaldi, Mayes, Barnes, Pirie, Hadley, Patterson & Wyper (1998). In Conway's (2002) conceptualisation, episodic memories are highly event specific and unless they link with more permanent autobiographical memories, soon degrade, most being lost within a day. Only those episodic memories integrated at the time of encoding or consolidated soon after remain accessible and can enter into the subsequent formation of autobiographical memory. Whether or not autobiographical memory differs neurologically or cognitively from episodic memory, it is not disputed that a person's record of life's experience relies on an accumulation of episodic memories. It is well established that amnesics have gross deficiency in making or retrieving episodic memories for events

that have occurred since their injury, although memory for events that occurred before their brain damage is often (but by no means always) intact (e.g., Baddeley & Wilson, 1986; Wilson & Baddeley, 1988).

Amnesics also have difficulty making post injury semantic memories, that is memory for facts and terms about the world (Gabrieli et al., 1988). However there is convincing evidence that in some cases anterograde semantic memory can remain selectively intact emanating from studies of patients who suffered hypoxic ischaemic injury in childhood who have severely impaired episodic memory and relative preservation of semantic memory, regardless of the age of onset of hippocampal damage (Vargha-Khadem et al., 2002). One of these rare examples is the patient, Jon, who apparently has the ability to acquire new semantic information, and performs normally on recognition tests, despite episodic amnesia from childhood (Baddeley et al., 2001). More evidence that semantic memory can be preserved in the absence of episodic memory is also offered by the case of K.C., who is unable to remember any personal events since suffering a severe closed head injury at the age of 30, with damage to multiple cortical and sub-cortical regions including the medial temporal lobes, yet whose semantic memory remains within the normal range (Tulving, 2002). These findings are consistent with the hypothesis that episodic memory is not necessary for either recognition memory or the acquisition of semantic knowledge and present a serious challenge to the conventional 'common sense' view of the episodic/semantic memory process, which assumes that semantic learning comes about as a result of an accumulation of episodic experiences (Squire & Zola, 1998; Tulving & Markowitsch, 2008) and go some way towards validating an alternative view that memory can operate independently at a lower perceptual or semantic level. In Tulving's (2002) model, different aspects of incoming information are processed in a serial manner at the perceptual, semantic or episodic level. According to this serial-parallel-independent (SPI) conceptualisation - which remains in dispute - storage and retrieval can be achieved independently from any level of the hierarchy: perceptual and semantic information need not go 'through' episodic memory in order to be successfully stored and retrieved, in fact counter-intuitively, the opposite is true, episodic memory must first pass through the semantic system.

The correlation between hippocampal damage in humans and some form of generalised memory defect has been established for over 50 years (O'Keefe & Nadel, 1978). However, there is convincing evidence which casts doubt on the simple, central role of the hippocampus in episodic memory in favour of a much more complex relationship between various anatomical structures, damage to which is classically associated with amnesia (Aggleton & Pearce, 2001). It appears that memory involves sites spread across the neocortex, but the principal reason for memory failure arises through damage to the hippocampi, limbic system and the surrounding cortex and their connecting pathways. There is also evidence that the frontal lobes are heavily involved in episodic memory processes indicating that the left pre-frontal cortex is more involved in encoding episodic memory, while the right pre-frontal cortex is more involved in retrieval (Nyberg, Cabeza and Tulving, 1996; Tulving, 2002). However, memory is

not the property of brain regions operating in isolation, but rather of brain networks (Maguire, 2001). Each structure can be regarded as a bottleneck through which bits of information must pass to be successfully consolidated. Damage to any of these structures or their connecting pathways can consequently result in diaschisis, or remote disruption to the system which can produce memory difficulty (Tulving & Markowitsch, 1998). Conway makes the case that episodic memory is a neuroanatomically separate memory system which retains records of sensory-perceptual processing derived from working memory (Conway, 1992, 1996; Conway & Pleydell-Pearce, 2000). Episodic memories are represented in the brain regions most closely involved at the time of encoding of the experience (the occipital lobes and parts of the temporal lobes). In a meta analysis Nyberg et al., (1996) identified several right hemisphere sites as critical in remembering details from very recent events while Tulving, Kapur, Craik, Moscovitch and Houle (1994) postulate that the right pre-frontal cortex is specialised for encoding episodic memory, while the left PFC mediates retrieval. Regions of the occipital lobes have been shown to be active in both word recognition (Gonsalves & Paller, 2000) and the recall of autobiographical memory (Conway, 2002) and in episodic memory (Nyberg et al., 1996). An episodic memory task also showed strong activation of the right temporal and occipital lobes Conway (2002). There are obvious difficulties in distinguishing whether or not a memory failure is due to faulty encoding or faulty retrieval. However neuroimaging studies of the frontal lobes have attempted to dissociate the two processes. In a review of the work in the field, Fletcher and Henson (2001) acknowledge that the task is rarely straightforward because both encoding and retrieval might share a number of sub-processes, for example both may involve searches of semantic memory, first to produce a rich memory trace of the encoding episode and later to generate cues that aid access to the trace (Fletcher & Henson, 2001). However, findings strongly suggest greater right than left FC engagement in encoding episodic memory and greater left than right FC involvement in retrieval and that this holds true whether or not the participants know that their performance will be tested later (Kapur, Craik, Tulving, Wilson, Houle & Brown, 1994). Conway, Pleydell-Pearce and Whitecross (2001) also showed strong activation of the right temporal and occipital lobes in episodic memory task. However a consistent picture is yet to emerge of the functional neuroimaging of memory due to poorly defined cognitive processes, methodological inconsistencies and small sample sizes. Attempts to understand the localisation of memory function in the brain may de-emphasise the more global picture of integrated systems with widespread connections in the brain (Fletcher & Henson, 2001).

Studies of amnesic people, beginning with those of the famous patient Henry Molaison (Milner et al., 1966; O'Kane, Kensinger & Corkin, 2004) who suffered severe anterograde amnesia after bilateral medial temporal lobe resection, have compellingly demonstrated the role of the hippocampus and surrounding cortex for a range of memory functions including acquisition of episodic information about events as well as semantic factual information. The standard view of memory consolidation is that the hippocampus is required for the encoding of memory traces which are then

dispersed over sites in the neocortex and are stored. Initially the hippocampus is required for recall but over a period of time the role of the hippocampus is rendered unnecessary to recall. However some observers have called this view into doubt and a multiple memory trace theory has been propounded in which the hippocampus is always deemed necessary for the retrieval of episodic and spatial information, no matter how recent or how long ago it was encoded. Under this view, it is only semantic information, or 'gist information,' which becomes established in the neocortex and will survive damage to the hippocampal regions (Nadel, Samsonovich, Ryan & Moscovitch, 2000). PET and brain scanning evidence is conflicting for the involvement of the hippocampus in both encoding and retrieval of past events. Maguire (2001) reviewed eleven studies of various methodologies, out of which three showed no hippocampal involvement in retrieval of autobiographical memory (Andreasen, O'Leary, Cizaldo, Arndt, Rezai, Watkins, Boles Ponto & Hichwa, 1995; Andreasen, O'Leary, Paradiso, Cizaldo, Arndt, Watkins, Boles Ponto, & Hichwa, 1999; Conway, Turk, Miller, Logan, Nebes, Meltser, & Becker, 1999), which may have been due to cross-study differences in methodology and scanning techniques. However, in a time scale study, which graded memories for their recency or remoteness, Maguire, et al. (2001) found evidence of hippocampal involvement no matter how old or recent the episode and in half the participants, the more remote the memory, the more hippocampal activity occurred, which concurs with the view that the hippocampus is necessary for autobiographical memory no matter how recent or remote the memory. Whichever view is taken, the hippocampus appears undoubtedly necessary for encoding and retrieving recently experienced episodes.

Formerly, memory failures were assumed be attributable to faulty encoding (e.g., Butters & Cermak, 1975; Craik & Lockhart, 1972) or faulty storage (e.g., Milner, 1966; O'Keefe & Nadel, 1978) relying on the postulate that encoded memories leave behind persistent memory traces or engrams in the nervous system and that recall failure was due to poorly encoded and stored memories having decayed or being overwritten. Nowadays Tulving's (1974) alternative hypothesis - 'cue dependent forgetting' - is generally considered more conceivable, at least in terms of normal memory. Under this paradigm, encoding and storage may in fact have succeeded but forgetting has occurred because of retrieval failure (Roediger & Guynn, 1996). Memory for an event comes from both the memory trace and the retrieval cue, i.e. the information present in the individual's cognitive environment when retrieval occurs (Tulving, 1974).

### **Conceptual, practical and methodological issues**

The majority of investigations underpinning theories of memory come from work carried out in the laboratory, using easily standardised materials such as word lists or pictures. Where conditions were ecologically more valid, such as in the cognitive interview studies aiming to facilitate accurate retrieval, there was a concomitant lack of control, which makes it difficult to tease out the effectiveness of various components of the technique. Naturalistic materials and verbal exchanges will always present

this problem. However it was felt that the accumulated findings of the research into episodic memory must apply to everyday memory function, and that it was time to make the attempt to apply them in the real world. The stated aim of this study was to aid episodic recall of a recent event, in this case an eight minute viewing of a film excerpt, in ecologically valid circumstances. Episodic memory is a hypothetical construct which, according to Tulving, (2002) overlaps and extends beyond a widely distributed network of brain regions involved in other memory systems: for example it shares many features with semantic memory. The memory task deployed in this study must involve many aspects of memory, particularly pre-morbid semantic knowledge of the world, along with recognition memory, all of which may have been relatively damaged or spared by brain pathology.

In experimental terms there is a subtle problem concerning scoring the recall of an experienced event. While one set of researchers aims to enhance veridical recall, for example by using the cognitive interview, with the presumption that such a thing is achievable, others (e.g., Loftus, 1991) have over many years convincingly demonstrated that this is hardly possible. As far back as the 1930s Bartlett's explorations of memory led to the surprising discovery that there is no such thing as accurate episodic recall, even for those with normal memory, since we all 'reconstruct' events to fit our cultural background and personality. His large body of classic studies in remembering showed an extraordinary variety of interpretations can be made by different observers of the same written or pictorial material (Bartlett, 1932), which led him to the conclusion that "literal or accurate recall is an artificial construct of the laboratory," (Bartlett, 1932, p.29). In fact it can be argued that veridical recall, while desirable in laboratory and neuropsychological testing, is largely irrelevant when we tell stories of recent happenings in a social situation - and may not even be possible. In real life, our memory of events, is influenced by our own perspective and no doubt unconsciously reconstructed to fit what we believe happened. We do this ourselves without realising it - all Bartlett's work involved free recall with no prompting or cueing - and we can be influenced by others. Over many years, Loftus (1975, 1991) has demonstrated that people's honest evaluations of an event can easily be distorted by those who question them, while remaining a genuine reflection of the perception of the rememberer. While it is true that any theory of memory should be able to accommodate such socially important forms of remembering (Loftus, 1975), there is no doubt that setting up experiments based on natural recall, which attempt to validate this premise, involve complex methodological problems in the area of standardisation and scoring. Our memory for episodes (e.g. what happened on the bus on the way to work) is based on multi-dimensional experiences of rapidly changing events and recall is necessarily our interpretation of the *meaning* of the event. Therefore when considering what constitutes correct recall for scoring purposes, some issues need to be addressed: participants' interpretation of events may vary from those who drew up the 'definitive' score sheet, yet be equally valid; participants may recall items and events which the scorer failed to notice; also genuine misinterpretations - 'it could be seen that way' - need to be distinguished from confabulations where frankly erroneous material is introduced.



### **Rationale for the study**

In Medved's (2007) study, the interlocutors often halted, 'interrogated' or ignored what was being said during conversations with people with organic memory problems. It is suggested here that this may represent the general approach of those engaging in conversation with people with memory problems which raises the possibility that an alternative interpersonal approach could augment the recall of those with memory problems, resulting in a more fulfilling conversation for both parties.

The rationale for the study reported here, based on the findings of the research literature described above, was that a 'cued conversation' containing imaginal context reinstatement, followed by a majority of cues in the form of open questions and reflecting back, may result in more items being recalled from a recently viewed film excerpt, than a 'normal conversation' with no context setting, a predominance of closed questions and minimal 'reflecting back.'

There remain unresolved empirical problems surrounding the issue of context setting (Smith, 1988) and no published work in which imaginal or physical context setting has been used with people with organic memory damage, though as Smith and Vela (2001) have stated, knowing when and how context reinstatement is effective would be useful for those working in applied settings. However, based on the reported effectiveness of the technique in the cognitive interview (Memon & Higham, 1999), and other work (Godden & Baddeley, 1975; Smith et al., 1978; Smith, 1988), imaginal environmental context setting was included in this study and applied before the free recall phase of the cued conversation. It was hypothesised that if tested it would provide, for the first time, an indication of the technique's usefulness or otherwise in this population. The study proceeded on the assumption that the questioner would have no prior knowledge of the event being recalled. Therefore any cues to further recall would need to be based on the words of the participant alone. Cues, in the form of questions and other verbal exchanges, would initially arise from items generated in free recall.

Based on the observations of Wilson (1987) and Baddeley's (1982) suggestion, and on work on the cognitive interview which revealed that ineffective interviewers asked too many closed questions (Fisher, 1986; Fisher & Guiselman, 1989, 1992), it was hypothesised that the potential differential effectiveness of open questions may lie in Tulving's encoding specificity hypothesis - similarity of memory traces formed during encoding and memory probes used at retrieval appears to be involved in successfully converting a potential memory into conscious awareness (Thomson & Tulving, 1970; Tulving & Pearlstone, 1966; Tulving & Osler, 1968; Tulving & Thomson, 1973).

Closed questions may also have a cueing effect since they may reduce interference from competing items in episodic memory by presenting straightforward alternatives. However, since open questions engender a more narrative response they may be more effective than closed questions which offer a simple choice of alternatives as answers. Feasibly all types of questions could also activate priming, the unconscious improvement in memory based purely on recent exposure (Hamann et al., 1995).

The technique of 'reflecting back,' which represents a particular type of open question, may have attributes of value which merit exploration. Reiterating information may act to redirect the participant to the focal context (Smith & Vela, 2001) of the material, while encouraging multiple searches for more memory fragments which in turn spark further recall for according to Baddeley (2004), we access our memory by using a fragment of our remembered experience as a key to the whole. Also, it could be argued, that by drawing the rememberer's attention back to the original experience 'reflecting back' may also focus attention on the episode and encourage successful retrieval by engaging 'retrieval mode,' a necessary condition for remembering past experiences (Lepage et al., 2000; Tulving, 1983;

It is also speculated that 'reflecting back' and using open questions may by encourage multiple attempts at retrieval - retrieval practice - which may induce additional items to be recalled (Schacter et al., 1985); hypermnesia, in which more items tend to be remembered if testing is repeated; or the reminiscence effect in which previously 'forgotten' items are subsequently brought to mind (see Payne, 1987 for review). What is not clear is whether the recall attempts needed to produce these effects need necessarily encompass the whole of an experienced episode, or whether retrieval of sections of the material can be enhanced in the course of one extended attempt. In experimental work it is the researcher who defines what constitutes the 'episode' to be tested. While ostensibly this study does not differ in that it focuses on a single extended attempt at retrieval, in the form of a conversation, it could be argued that the material incorporates a sequence of discrete mini-episodes and that therefore each section of the action could benefit from retrieval practice, a process which could be facilitated by verbal prompts. Viewing a film excerpt, as in this study, would appear to circumscribe the episode as 'all that is contained in the film excerpt.' Yet when score sheets were being prepared for the purposes of data analysis it became clear that the action could be readily split into various stand-alone coherent pieces, with a beginning, middle and an end, each of which could stand as 'episodes' in their own right.

The study methodology involved comparison of two types of conversation, each with different types of prompts, to test their relative effectiveness. Yet if a conversation is to proceed in an ecologically valid manner, without being stilted or artificial, it is impossible to exclude completely certain types of prompts or questions. This issue was addressed through the design of separate protocols for each type of conversation - piloted prior to the study - in which different types of prompts are allowed to predominate, according to the type of conversation employed. Also, the study was designed to mimic a natural conversation about an event of which the questioner had no prior knowledge, but

due to practical constraints the researcher in this case was necessarily well aware of the contents of the material. This was addressed by checking the transcripts for any extraneous material which may inadvertently have been introduced by the researcher.

There were two phases in the study: Free recall and a questioning phase designated in this study as ‘dyadic recall,’ in which cues and prompts were applied according to the protocols for the two conditions. The term dyadic recall was used to reflect the more free-form, interactive nature of the conversation which differed, for example from a structured interview or a standardised set of questions.

Empirically the aim of the study was to test the following hypotheses:

- a. *Effectiveness of conversation type*: If one type of conversation (cued or normal) is more effective, it will result in more items being recalled overall.
- b. *Effectiveness of imaginal context setting*: If imaginal environmental context setting is effective it will result in better free recall in the cued conversation than the normal conversation.
- c. *Effectiveness of dyadic phase*: If questioning of participants in the dyadic phase of the cued conversation is more effective, it will result in better dyadic recall scores than the normal conversation group.

## METHOD

### **Design**

#### **Effectiveness of conversation type**

Fifteen pairs of participants, matched by their scores on the Rivermead Behavioural Memory Test-11 (Wilson et al, 1991), ( $N=30$ ), were randomly allocated to the cued or the normal conversation condition. The conversations were conducted in accordance with protocols previously designed by the researcher. Analysis of Co-Variance (ANCOVA) was employed using the total number of idea units scored in each condition to test the relative effectiveness of the normal and cued conversation overall. As a further test of hypothesis *a* above, a one-way between groups analysis of covariance (ANCOVA) with conversation type (cued vs. normal) as the independent variable, total recall score as the dependent variable, and RBMT-11 scores as a covariate was performed.

#### **Effectiveness of conversation phase**

In both conditions an uninterrupted free recall phase was followed by a dyadic recall phase in which the experimenter used verbal prompts as cues. In the cued conversation condition, free recall was preceded by imaginal context re-instatement. To examine the effects of conversation type on the two recall phases a one-way between groups multivariate analysis of covariance (MANCOVA) was performed, with conversation type (cued vs. normal) as the independent variable, the recall phases (free recall and dyadic recall) as dependent variables, and RBMT-11 scores as a covariate.

To evaluate the effects of conversation type on each of the dependent variables separately, Roy-Bargmann stepdown analysis was performed, with the results of univariate analyses for each dependent variable also being considered to assist in interpretation of the stepdown statistics.

### **Effectiveness of types of prompts**

For the purposes of this analysis, idea units elicited in response to different categories of prompts (see coding of transcripts, below) were labelled in correspondence with the type of prompt used. For example a ‘closed idea unit’ is the type obtained in response to a closed question. Pearson’s Chi-squared was used to compare the numbers of idea unit types recalled in each condition. To examine the effectiveness of prompt types, regardless of conversation style, the data were collapsed across conditions and the total scores of idea unit types were examined.

### **Coding of transcripts**

In this study all the experimenter’s words in the dyadic phase, were considered to act as potential verbal prompts on the simple basis that they aimed to produce a response from the participant. Therefore the transcription of the experimenter’s discourse was coded into categories so that the number of idea units elicited in response to different types of verbal prompt could be quantified and analysed. The categories were:

- Closed questions: These invite a yes/no response or give a forced choice. For example, ‘Was it black or grey?’ ‘Do you remember what happened next?’ ‘Can you recall?’<sup>4</sup>
- Classic open questions: These do not invite a yes/no answer, are not forced choice but and invite a narrative response. For example, ‘What happened when they got there?’ ‘What happened next?’ ‘Describe to me’ or ‘Tell me about.’ They need not end in a question mark.
- Reflecting back: These verbalisations do not invite a yes/no answer, are not forced choice and invite a narrative response. Their defining characteristic is that they paraphrase the participant’s previous description of events without additions or contradictions. For example, ‘So they are coming up to this building and they are going to climb onto this shed and then onto the balcony. You tell me..’
- Other: This category included all residual input, including interjections such as ‘Yes, I see’ or ‘OK’ or comments not directly related to the material. For example ‘That’s Laurel and Hardy for you.’

Prompts that started out as either a classic open question or reflection or in the category of ‘other’ but concluded with a closed question in a single exchange were coded as closed.

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<sup>4</sup> Ostensibly open questions are all those exchanges which do not invite a yes/no or forced choice answer. Therefore all verbalisations which were not coded as ‘closed,’ could be regarded as ‘open.’ However to refine the investigation, prompts not previously classified as closed questions, were coded in more detail.

## **Materials and Apparatus**

### *The film*

Participants attempted to remember what they could from an eight-minute excerpt from the black and white Laurel and Hardy comedy film *Way Out West* (Laurel & Thorne, 1937). The material was chosen for its apparent memorability and its relative ease of scoring as described below:

- Memorability: While, because of its age, participants would be unlikely to be over familiar with the contents of the film, the characters are well known, which could prevent a floor effect during recall. Events in the film are logically sequential with no analepses or prolepses (i.e. interjected scenes that take the narrative back or forward in time) or cutaway scenes (i.e. interruptions for the insertion of another, unrelated scene) and there are just four characters. The film's humour may act to reduce stress and make the task less onerous for the participants.
- Ease of scoring: The action was comparatively easy to partition into segments. There is relatively little speech and when there is, only one person speaks at once, making participants' recall of dialogue both easier for them to recall and easier to score. The film is in black and white, reducing the number of possible idea units, which could be given regarding the colour of objects.

Participants viewed the film excerpt on DVD on a computer screen. Conversations were recorded onto cassette tape and manually transcribed using a transcription machine and computer word processing programme.

### *The storyboard*

The action in the film excerpt was broken down by the researcher by creating a photographic storyboard using stills taken at significant points in the film photographed from the computer screen using a digital camera (See example sheet at Appendix IV). Storyboarding is a technique used by film makers whereby a sequence of images is created to describe the content of a film. None of the published research using recall of moving images appears to have made use of this method. Storyboarding helped the researcher gain thorough familiarity with the film which would be needed when scoring and provided visual reference points to the sequence of action which could be used to re-check participants' recall with the original film.

### *Score sheets*

The film excerpt was exhaustively broken down into idea units by the researcher who then drew up a detailed score sheet listing idea units that she felt may be recalled from the film. Score sheets were used in conjunction with the storyboard (see sample page of score sheet at Appendix V).

The idea units from the film were listed in sequence and grouped into 36 sections (referred to as ‘slides’ on the score sheets) to facilitate referral back to their position in the film. The sections represented a chunk of coherent action, specific joke, segment of conversation, or piece of slapstick. The running time into the film of when the part of action occurred was also listed to assist referral back to the original film for checking purposes.

### **Participants**

Thirty participants (17 male and 13 female) with a mean age of 48.6 (See Table 5.1) were recruited from attendees at The Brain and Spinal Injury Centre in Salford, Greater Manchester, a registered charity which helps people who are recovering from brain injuries. All have a brain injury or suffer from a neurological condition and all report memory difficulties which have an impact on their daily lives. Most participants were known to the experimenter and the majority had attended a series of ‘memory workshop’ training groups run by her. Due to the practical difficulties in matching participants by age, ability and similarity of lesion the two groups were randomly allocated to one of two conversation conditions based on a simple performance measure, their scores on the RBMT-11. Those who scored in the normal range, nevertheless reported memory difficulties and were included in the study (see footnote <sup>3</sup> at page 46). They were administered the The memory skills questionnaire (Powell & Malia, 1999, see Appendix VII) which represents a subjective record of the everyday memory behaviour of the person completing the questionnaire with regard to typical everyday memory failures. The authors state that a score of between 8 and 20 indicates the person completing the form may have a poor memory and may benefit from using compensatory strategies. Only the self scores were included in this study.

Table 5.1: Characteristics of participants paired by conversation condition.

| Pp. | Gender | Age | Type of Injury/condition | RBMT profile score | Memory level | Memory skills questionnaire score | Conversation group |
|-----|--------|-----|--------------------------|--------------------|--------------|-----------------------------------|--------------------|
| 1   | F      | 50  | SAH                      | 22                 | Normal       | 9                                 | Normal             |
| 2   | M      | 58  | CVA                      | 21                 | Poor         |                                   | Cued               |
| 3   | F      | 48  | Enceph                   | 16                 | Mod          |                                   | Normal             |
| 4   | M      | 46  | CVA                      | 11                 | Mod          |                                   | Cued               |
| 5   | F      | 55  | SAH                      | 17                 | Poor         |                                   | Normal             |
| 6   | F      | 38  | TBI                      | 16                 | Mod          |                                   | Cued               |
| 7   | F      | 54  | SAH                      | 23                 | Normal       | 11                                | Normal             |
| 8   | M      | 33  | SAH                      | 23                 | Normal       | 13                                | Cued               |
| 9   | M      | 61  | Tumour                   | 22                 | Normal       | 11                                | Normal             |
| 10  | F      | 49  | MS                       | 20                 | Poor         |                                   | Cued               |
| 11  | M      | 48  | TBI                      | 10                 | Moderate     |                                   | Normal             |
| 12  | F      | 52  | SAH                      | 17                 | Poor         |                                   | Cued               |
| 13  | F      | 44  | TBI                      | 9                  | Severe       |                                   | Normal             |
| 14  | M      | 48  | SAH                      | 7                  | Severe       |                                   | Cued               |
| 15  | F      | 73  | CVA                      | 18                 | Poor         |                                   | Normal             |
| 16  | M      | 42  | Colloid cyst             | 19                 | Poor         |                                   | Cued               |
| 17  | M      | 33  | TBI                      | 14                 | Mod          |                                   | Normal             |
| 18  | M      | 34  | Hydroceph                | 19                 | Poor         |                                   | Cued               |
| 19  | M      | 69  | SAH                      | 22                 | Normal       | 11                                | Normal             |
| 20  | F      | 47  | Tumour                   | 24                 | Normal       | 20                                | Cued               |
| 21  | M      | 54  | Cerebral Vasculitis      | 21                 | Poor         |                                   | Normal             |
| 22  | F      | 53  | CVA                      | 19                 | Poor         |                                   | Cued               |
| 23  | M      | 35  | Enceph                   | 12                 | Moderate     |                                   | Normal             |
| 24  | M      | 74  | CVA                      | 19                 | Poor         |                                   | Cued               |
| 25  | F      | 37  | MS                       | 20                 | Poor         |                                   | Normal             |
| 26  | M      | 28  | TBI                      | 19                 | Poor         |                                   | Cued               |
| 27  | M      | 29  | TBI                      | 19                 | Poor         |                                   | Normal             |
| 28  | F      | 28  | TBI                      | 19                 | Poor         |                                   | Cued               |
| 29  | M      | 36  | CVA                      | 15                 | Mod          |                                   | Normal             |
| 30  | M      | 72  | Parkinson's              | 14                 | Mod          |                                   | Cued               |

Key: CVA = Cerebro-vascular accident (stroke), Hydroceph = hydrocephalus, TBI = Traumatic brain injury, MS = Multiple Sclerosis, SAH = Sub-arachnoid haemorrhage, Enceph = Encephalitis.

## Procedure

Prior to taking part in the study all participants were tested by experimenter using the RBMT-11 (Wilson et al., 1991) and later given individual feedback on the results. The six participants whose scores fell into the Normal range as laid down by the RBMT-11 nevertheless still reported memory problems and were therefore invited to complete an Everyday Memory Questionnaire (Powell & Malia, 1999) and given feedback. Participants watched the film excerpt alone in a therapy room at the Brain and Spinal Injury Centre. They were told that during the viewing the researcher would be standing outside the door of the room in case she was needed. Prior to watching the film they were told they would later be asked about what they remembered from the film. They were told: "This is not a memory test. I just want you to watch the film as you would normally and enjoy it, then I will ask you some questions." At the conclusion of the film excerpt participants took a twenty-minute break during which they were allowed to walk around the centre, talk to people, or get a cup of tea. They were told, "You can do what you like for twenty minutes now. Then I will come and find you. Please don't talk about the film to anyone."

Participants were then taken to a different room from the one in which they viewed the film and the conversation proceeded according to protocols laid down for the condition type. During the twenty minute break the researcher re-familiarised herself with the relevant protocol and kept a copy with her during the conversation for reference. As one of the aims of the procedure was to replicate a situation where the researcher was not present at the event being recalled she did not acknowledge familiarity with the film and attempted not to introduce any material which she could only have known by having watched the film herself. If, when scoring the transcript, it was found that extraneous material was inadvertently introduced, the corresponding answer was not scored.

## Conversation protocols

### *Normal conversation protocol*

- Free Recall: The participant is instructed: 'Tell me everything that you can remember from the film excerpt you have just seen,' and then makes an uninterrupted free recall of the events. When the participant indicates that he or she has said everything they can remember, for example by saying: 'That's it,' or 'That's everything,' the experimenter begins the dyadic recall phase.
- Dyadic Recall: The experimenter uses a majority of closed questions, generated from the recollections of the participant, and avoids open questions and reflecting back or paraphrasing. For example 'Can you tell me more about what happened in the film?' 'Do you know what happened first?' 'Can you remember what happened next?' 'Can you tell me what they were doing?' 'Can you recall how many people there were in the film?' 'Do you know what they looked like?' 'Do you know what were they wearing?' The dyadic phase ends when the participant indicates that he or she can remember nothing else after being asked: 'Are you sure there is nothing else that you can tell me?'



### *Cued Conversation protocol*

- Context reinstatement: The cued conversation protocol demands that imaginal context reinstatement, which has been shown to boost free recall, be introduced prior to the free recall phase. The rationale for this was that if additional idea units were remembered in free recall they would form the basis for an increased number of prompts and reflections in the dyadic phase, enhancing overall recall in the cued conversation.<sup>5</sup> Context is set by the researcher using a spoken preamble with the general format: ‘In a few minutes I’m going to ask you what you can remember from the film you have just seen, but before I do that I want you to put yourself back into the situation when you came into the room to watch the film. Close your eyes and really imagine the room. What were you thinking about at the time? Were you comfortable? Warm? Cold? Nervous? Did you notice anything about the room? (Included here is individual re-instatement of the individual participant’s circumstances, e.g. ‘When you arrived you said you were sorry you were late, you had trouble with the bus’). Now I want you to really try to make an image in your mind of what the room was like. Think about the circumstances and the impressions that you had before you started to watch the film. Tell me when you are ready.’
- Free Recall: When the participants indicate readiness they are instructed ‘I would like you to describe for me everything you can about the film you saw. Take your time to tell me about it. There’s plenty of time. It doesn’t matter if you get things wrong. I want you to tell me everything you can. Say everything you think happened, even if you are not sure. You can guess if you like.’ The participant then makes a free recall of the film excerpt. Free recall is ended when the participant indicates that that is all they can remember.
- Dyadic Recall: The researcher avoids the use of closed questions and employs reflecting back and open questions. The researcher begins by summarising what the participant has said in free recall. For example by beginning: ‘First, I’m just going to go over what I think you have said,’ then paraphrasing the words of the participant (reflecting back). This continues periodically throughout the conversation when the participant stops talking. The researcher continues by using what has been elicited from the free recall and the on-going narrative of the participant. For example, ‘I’d like you to think about anything else that you noticed about the place where the action happened and describe it for me.’ ‘Think about anything you found funny or unusual and describe it to me.’ ‘I’d like you to take me through what you saw again from the beginning.’

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<sup>5</sup> Participants in the pilot study felt that people with memory impairments may have difficulty imagining the environment without some prompting. Therefore the researcher used a spoken preamble to guide the participants.

### **Adherence to protocols**

Analysis indicated that the protocols were adhered to. There was a significant association between the type of prompts used: closed questions, classic open questions, reflecting back and 'other' and conversation condition (Chi-squared 137.2,  $p < 0.001$ ,  $DF = 3$ ), which was unlikely to have arisen as a result of sampling error. A Cramer's V of 0.273, indicated that just under seven and a half per cent of the variation in frequency counts of the type of prompts used can be explained by the type of conversation employed. The protocols stipulated that more closed questions be used in the normal conversation and that reflecting back be avoided.

In the normal conversation condition 60.9% of all prompts were closed questions compared with 35.6% in the cued condition. Reflecting back was ten times more prevalent in the cued than normal conversation (2.9% and 20.9%).

Analysis of the transcripts of the researcher's words also showed adherence to the protocols in that context setting was carried out prior to free recall for all participants in the cued conversation conditions and for none in the normal conversation.

### **Scoring of idea units.**

Idea units were scored by reference to the transcripts of both the free and dyadic recall phases and the counts were marked on score sheets. As scoring proceeded, new idea units introduced by the participant but not included in the original score sheet, were checked by reference back to the film and added to the score sheet in the words of the participant as additional idea units. In this way the number of idea units on the score sheet increased as more participants' transcripts were scored, however there was no maximum total of idea units to be recalled, nor was the number of errors made scored. Single words included in descriptions of objects and people, e.g. 'barrels,' 'saddlebag,' 'bowler hat,' 'shotgun,' 'moustache,' were scored if they were recalled with a word corresponding to one on the score sheet or a synonym, such as 'water butt' for 'barrel,' or 'donkey,' for 'mule,' 'pulley,' for 'block and tackle.' Propositions describing pieces of action, which were a legitimate interpretation of what happened on the film, were scored even though the words used were not the ones on the score sheet. For example, 'They scuttled off round the corner,' rather than 'They ran away,' or 'He tugged and tugged and he went up,' for 'He pulled him up,' 'He got a whack on the head,' for 'He hit him on the head'. Differences in interpretation of the action were checked by reference to the storyboard and the original film. If the participant's view of what happened could be seen as valid, it was scored as correct. Opinions and comments such as 'It was very painful,' or 'He was cross,' were not scored. Confabulations were noted but not scored. Each idea unit was scored only once, but repetitions were noted. Scoring of free recall and dyadic recall was done separately. Idea units scored in free recall were not included in dyadic recall.

### **Inter-rater reliability**

The transcripts were first scored by the researcher. Two from each condition were then chosen at random and scored by an independent scorer. Before scoring, the independent scorer first watched the film, then read through the transcripts once. She then scored first for the number of valid idea units scored and secondly for agreement on the classification of the types of prompts used. Inter-rater reliability analysis was performed using the Kappa statistic for agreement between the two raters on whether a valid idea unit had been scored. All Kappa statistics showed substantial agreement (Landis & Koch, 1977)

- Idea units: Inter-rater reliability for scoring of idea units (agreement as to whether an idea unit had been gained) was  $Kappa=0.925$ ,  $p = 0.001$ . Four idea unit scores awarded by the researcher were initially disputed as not being valid and the same number where the independent scorer considered a score should have been awarded when the researcher had not given a score. These discrepancies were discussed and agreement reached on those found to be as a result of a checking error or repetition of an idea unit. There was one instance of an extraneous cue being introduced by the researcher which had not previously been mentioned by the participant. This was not scored.
- Types of prompts: Inter-rater reliability for the scoring of types of prompts was: closed questions,  $Kappa=0.820$   $p<0.001$ ; classic open,  $Kappa=0.838$   $p<0.001$ ; reflecting back,  $Kappa=0.658$   $p<0.001$  and 'other',  $Kappa=0.694$   $p<0.001$ . Discrepancies in the scoring of types of questions arose initially, mainly as a result of misinterpretation of the definitions of the types of prompts, in particular where a question began as open and ended as a closed question. Scoring by the independent rater was more generous in terms of idea units scored than that of the researcher.
- Observations from the independent scorer were that the transcripts were usually coherent even though sections of the action were missing. She noted new information was coming out during the late stages of the dyadic phase. Also there appeared to be good correspondence between the descriptions of idea units made by the experimenter and the participants' recall.

### **Length of conversations and number of prompts**

The word count of the two types of conversation was compared, as were the numbers of prompts used in the dyadic phase of both conversation types.

## RESULTS

The data set was analysed to test the hypotheses that: (a) one type of conversation is more effective than the other in terms of more idea units being recalled; (b) imaginal context reinstatement enhances free recall; (c) conversational cueing improves recall in the dyadic phase.

Contrary to the first two hypotheses, preliminary analysis of the mean recall scores (see Table 5.2) indicated no significant difference between the total recall scores of the two conversation types,  $t(14) = 1.07$   $p = .302$ , or between the free recall scores of the two conversation types,  $t(14) = -1.50$ ,  $p = .157$ . Thus, with respect to the first hypothesis, although mean overall recall was higher in the cued conversation condition the difference was non-significant. With respect to the second hypothesis, imaginal context setting did not increase the number of idea units remembered in free recall, in fact, the direction of the difference in the means was contrary to that hypothesised, free recall being lower in the cued conversation where context setting was carried out than in the normal conversation where it was omitted. The third hypothesis was supported however. Here, there was a significant difference in the dyadic phase scores,  $t(14) = 4.07$ ,  $p = .001$ , with more idea units being recalled in the dyadic phase when a cued conversation protocol was followed. Overall, lower free recall scores in the cued conversation were offset by higher scores in the dyadic phase. In the normal conversation, the opposite pattern was observed: higher free recall scores were balanced by lower dyadic phase scores. These differences explain why there was no significant difference between the conditions when the phases were taken together.

Table 5.2: Means and standard deviations of total, free recall and dyadic recall scores across normal and cued conversation conditions,  $n = 15$ .

|                     |               | Mean  | SD    |
|---------------------|---------------|-------|-------|
| Normal conversation | Free Recall   | 29.30 | 15.50 |
|                     | Dyadic Recall | 19.30 | 7.80  |
|                     | Total         | 48.60 | 14.00 |
| Cued conversation   | Free Recall   | 21.90 | 12.90 |
|                     | Dyadic Recall | 32.10 | 12.70 |
|                     | Total         | 54.00 | 16.70 |

The above results compared the mean recall of the two interview groups paired by their similarity in scores on the RBMT-11. However, because the wide variation in participants' memory scores (See Table 5.3) could act as a confounding variable, further analyses were conducted controlling for the effects of memory level.

Table 5.3: RBMT profile scores of participants.

|                 | <i>M</i> | <i>SD</i> | Min | Max  |
|-----------------|----------|-----------|-----|------|
| RBMT-11 profile | 17.4     | 4.5       | 7.0 | 24.0 |
| score           |          |           |     |      |

### Effect of conversation type

As a further test of hypothesis *a* above, a one-way between groups analysis of covariance (ANCOVA) with conversation type (cued vs. normal) as the independent variable, total recall score as the dependent variable, and RBMT-11 scores as a covariate was performed. Levene's test for homogeneity of slopes, carried out in advance of the ANCOVA, was non-significant,  $F(1,26) = 0.343$ , partial  $\eta^2 = .013$ ,  $p = .563$ . The ANCOVA showed that type of conversation had no significant effect on total recall when memory level was controlled,  $F(1,27) = 1.002$ ,  $p = .326$ . There was a significant relationship between the memory level covariate and total recall score,  $F(1,27) = 6.005$ , partial  $\eta^2 = .182$ ,  $p = .021$ .

Adjusted means, standard deviations and confidence intervals for total recall score and normal conversation were  $M = 48.71$ ,  $SD = 13.96$ , 95%  $CI = 41.1$  to  $56.32$ , and for cued conversation  $M = 53.88$   $SD = 16.65$ , 95%  $CI = 46.27$  to  $61.49$ . Thus, there was no support for the hypothesis that one type of conversation would be more effective than the other in terms of more idea units being recalled overall (hypothesis *a*).

### Effect of conversation phase

To examine the effects of conversation type on the two recall phases a one-way between groups multivariate analysis of covariance (MANCOVA) was performed, with conversation type (cued vs. normal) as the independent variable, the recall phases (free recall and dyadic recall) as dependent variables, and RBMT-11 scores as a covariate. A test of homogeneity of variance/covariance matrices was non-significant, Box's  $M = 4.645$ ,  $F(3, 141120) = 1.428$ ,  $p = .232$ , and Levene's tests of the assumption of homogeneity of variance were also non-significant: free recall,  $F(1,28) = 0.143$ ,  $p = .708$ , and dyadic recall,  $F(1,28) = 2.223$ ,  $p = .147$ .

Results of multivariate tests indicated that type of conversation had an effect on the linearly combined dependent variables when the effect of memory scores was controlled, Wilks' Lambda =  $0.711$ ,  $F(2,26) = 5.282$ , partial  $\eta^2 = .29$ ,  $p = .012$ . Estimated marginal means and other statistics for the analysis are given in Table 5.4. Contrary to hypothesis *b* these show that free recall was greater for the normal conversation group than the cued conversation group, but that, in support of hypothesis *c*, dyadic recall was greater for the cued conversation group than the normal conversation group. The multivariate test of the relationship between the memory level covariate and the combined dependent variables after adjustment for the conversation group independent variable revealed a significant effect, Wilks' Lambda =  $0.786$ ,  $F(2,26) = 3.531$ ,  $\eta^2$  partial =  $0.21$ ,  $p = .044$ . However, this effect was not of major theoretical interest and therefore was not investigated further.

Table 5.4

Estimated marginal means for the MANCOVA including RBMT-11 scores as a covariate.

|                     |                    | Mean  | SE   | 95% CI        |
|---------------------|--------------------|-------|------|---------------|
| Group               | Dependent variable |       |      |               |
| Normal conversation | Free Recall        | 29.31 | 3.37 | 22.40 – 36.22 |
|                     | Dyadic Recall      | 19.34 | 2.75 | 13.70 – 24.97 |
| Cued conversation   | Free Recall        | 21.80 | 3.37 | 14.89 – 28.71 |
|                     | Dyadic Recall      | 32.00 | 2.75 | 26.36 – 37.63 |

To evaluate the effects of conversation type on each of the dependent variables separately, Roy-Bargmann stepdown analysis was performed, with the results of univariate analyses for each dependent variable also being considered to assist in interpretation of the stepdown statistics. The free recall dependent variable was given priority over dyadic recall in order of entry in the stepdown analysis, both because univariate tests showed that there was a significant main effect of the conversation type independent variable upon the dyadic recall dependent variable but not the free recall dependent variable, and because the free recall phase preceded the dyadic recall phase in the methodological procedure. This latter fact gave rise to the possibility that recall in the dyadic phase would be adversely affected by participants having already had the opportunity to recall items in the free recall phase: prioritising the free recall dependent variable ahead of the dyadic dependent variable in the stepdown analysis allowed statistical control for any such effect in assessing differences in dyadic recall across the two conversational groups. Thus, in the first stage of the stepdown analysis free recall was tested in a univariate ANCOVA and in the second stage of the stepdown analysis effects on dyadic recall were tested with free recall added to RBMT-11 scores as a second covariate (Tabachnick & Fidell, 2013). Effect sizes for the stepdown analysis were calculated using Smithson's (2003) NoncF3.sps and NoncF.sav SPSS files as recommended by Tabachnick and Fidell (2013).

A test of homogeneity of regression showed that the assumption of homogeneity for each step of the stepdown analysis was satisfied,  $F(2,24) = 0.82, p = .451$ . The first stage of the stepdown analysis indicated that there was no significant effect of conversation type on free recall,  $F(1, 27) = 2.486$ , partial  $\eta^2 = .08, p = .127$  (because this was the first stage of the stepdown analysis, these statistics were the same as those for a univariate test of the free recall dependent variable). These results indicated that imaginal context setting was not superior in cueing more free recall when memory level was statistically controlled (and, in fact, it should be remembered that Table 5.4 shows that the difference in means was in a direction contrary to the hypothesis). Therefore hypothesis *b* was not supported: imaginal context reinstatement did not enhance free recall. In the second stage of the stepdown analysis, however, there was a significant effect of conversation type on dyadic recall, stepdown  $F(1,26) = 7.481$ , partial  $\eta^2 = .22, p = .011$  (with a Bonferroni adjustment  $p_{crit} = .025$  for the two stages of the stepdown analyses). The adjusted dyadic recall score mean, standard error and confidence interval for the normal conversation group were  $M = 20.28, SE = 2.72, 95\% CI = 14.69$  to  $25.88$ , and for the cued conversation group  $M = 31.05, SE = 2.72, 95\% CI = 25.45$  to  $36.65$ . Univariate analysis also revealed a significant effect of conversation type on dyadic recall,  $F(1,27) = 10.612$ , partial  $\eta^2 = .282, p = .003$ . Thus, the protocol used in the dyadic phase of the cued conversation enhanced the number of idea units recalled when memory level was statistically controlled. The hypothesis that conversational cueing would improve recall in the dyadic phase (hypothesis *c*) was therefore supported. Although the stepdown effect size was smaller than the univariate effect size for the dyadic recall dependent variable, the fact that both types of analysis revealed significant effects shows that, in the event, the possibility that recall in the dyadic phase would be adversely affected by participants having already had the opportunity to recall items in the free

recall phase did not have a decisive impact upon the conclusions that can be drawn from the study. Nevertheless, it should be noted that the pooled within cells correlation between the free recall and dyadic recall dependent variables was  $-.309$ , the negative nature of this relationship perhaps indicating that the fact that the free recall phase preceded the dyadic recall phase did reduce recall in the latter phase.

### Effect of types of prompts

The results reported above indicate that the protocol used in the dyadic phase of the cued conversation positively affected the amount recalled. However, further analysis was undertaken to identify which types of prompts elicited the most idea units. For the purpose of this analysis idea units recalled in response to different types of prompts were labelled to correspond with the category of prompt used, e.g. 'closed idea units' refers to those which were elicited by closed questions. The characteristics of the different categories are described in the Method section.

There was a significant association between conversation condition and the number of idea units in each category, which is unlikely to have arisen as a result of sampling error, Chi-squared  $86.221$   $p < 0.001$ ,  $DF = 3$ . Cramer's  $V$  was  $0.33$ , indicating that just over ten per cent of the variation in frequency counts of the of idea units elicited in response to different types of prompts can be explained by the type of conversation employed (See Table 5.4).

Table 5.4 Chi-Square Crosstabulation of Conversation type by Idea unit type.

| Conversation Group x Idea Unit type |                     |          | Idea unit type |              |                 |       |       |
|-------------------------------------|---------------------|----------|----------------|--------------|-----------------|-------|-------|
| Conversation group                  | Normal Conversation | Count    | Closed         | Classic Open | Reflecting Back | Other | Total |
|                                     |                     | Expected |                |              |                 |       |       |
|                                     | Cued Conversation   | Count    | 181.0          | 62.0         | 14.0            | 33.0  | 290.0 |
|                                     |                     | Expected | 120.6          | 87.9         | 34.2            | 47.3  | 290.0 |
|                                     |                     | Count    | 143.0          | 174.0        | 78.0            | 94.0  | 489.0 |
|                                     |                     | Expected | 203.4          | 148.1        | 57.8            | 79.7  | 489.0 |
| Total                               |                     | Count    | 324.0          | 236.0        | 92.0            | 127.0 | 779.0 |
|                                     |                     | Expected | 324.0          | 236.0        | 92.0            | 127.0 | 779.0 |



Closed questions produced more than the expected count of idea units in the normal conversation and fewer than expected in the cued conversation. All other types of questions (classic open, reflecting back and other) produced fewer than the expected count of idea units in the normal conversation and more than the expected count in the cued conversation. These results were anticipated because the protocols for each type of conversation dictated the relative preponderance of different types of prompts (e.g. more closed questions in the normal conversation).

The results reported above are subject to the caveat that questions, prompts and interjections do not produce responses, in the form of the number of idea units, in isolation. It is recognised that the number of idea units recalled apparently as a result of one type of prompt or question is likely to be as a result of a build up of different types of verbal interaction which act together to produce a result. Two examples of the way in which types of verbalisations group together in the transcripts are illustrated below (Figs 5.1 and 5.2) using extracts from the dyadic phase of the cued conversation with participants C.H. whose profile score was 19 (poor memory) and J.D. who had an RBMT-II profile score of seven, placing him in the 'severe' category. C.H.

|  |  |   |   |   |   |
|--|--|---|---|---|---|
| <p><b>Closed Q:</b><br/>Do they climb onto something?</p> <p><i>It's like the side of the roof. An extension at the side. At the front there's a balcony. It's on the side</i></p> <p><b>3* Closed IUs</b></p> | <p><b>Closed Q:</b><br/>But they don't manage that?</p> <p><i>No, they fall through the roof</i></p> <p><b>1Rep IU</b></p> | <p><b>Closed Q:</b><br/>So they try again with the rope?</p> <p><i>Yes with the donkey</i></p> <p><b>1 Rep IU</b></p> | <p><b>C. Open Q</b><br/>Tell me about that. How does that work?</p> <p><i>Well they tie it to the donkey, Hardy sits on the donkey, gets the donkey to walk. Laurel goes up but he wants the tools off him. So Hardy gets off the donkey because Laurel's supposed to be heavier than the donkey the donkey goes flying up</i></p> <p><b>4 C.Open IUs</b></p> | <p><b>Closed Q:</b><br/>So the donkey goes up and he comes down again?</p> <p><i>I've missed one bit haven't I?</i></p> | <p><b>C Open Q:</b><br/>You tell me, I don't know.</p> <p><i>I think I have yes. Before the donkey bit, they climb on the roof don't they? And he falls through the roof and he comes through the door and Laurel thinks he's still in the building he's stood there waiting for him to come off the roof. He's stood on a big barrel or something and when he gets off he turns round and has a shock, he's stood there..</i></p> <p><b>5 C.Open IUs</b></p> |
|--|--|---|---|---|---|

Fig 5.1. Verbatim extract from the dyadic recall phase of the cued conversation with a participant with poor memory, C.H. (Answers in italics).

Key: RB = reflecting back, Closed Q = closed question, C. Open = classic open question, Rep = idea unit repeated from earlier in the conversation,\* = number of idea units scored by type of verbal prompt.

J.D.

|  |  |  |  |  |   |
|--|--|--|--|--|---|
| <p><b>R.B:</b><br/>Let me see if I've got this right. We've got Laurel and Hardy, the fat one and the thin one and they are coming up to this building with several floors on it - you mentioned a balcony....</p> <p><i>A shed and a balcony. The conversation was as to the way they were going to get up there from the shed to the balcony, was there an ascent they could use up the building.</i></p> <p><b>1 RB IU.<br/>2 Rep IU's*</b></p> | <p><b>Closed Q:</b><br/>So they were going to go from the shed to the balcony?</p> <p><b>Yes</b></p> | <p><b>Closed Q:</b><br/>Now you mentioned a rope before. Were they going to use the rope in this scenario?</p> <p><b>Yes</b></p> | <p><b>R.B:</b><br/>So they are coming up to this building and they are going to cimb onto this shed and then onto the balcony. You tell me...</p> <p><i>The thin one was pushing the fat one as best he could to get pushed him as hard as he could and then he fell through to the floor, through the roof.</i></p> <p><b>2 R.B. IU's *</b></p> | <p><b>Closed Q:</b><br/>So at that point there was no rope involved.</p> <p><b>No</b></p> <p><b>1 Rep IU.*</b></p> | <p><b>C. Open Q:</b><br/>O.K. So where did the rope come in?</p> <p><i>I think they must have...I'm not a hundred per cent sure. Possibly decided to use the rope</i></p> |
|--|--|--|--|--|---|

Fig 5.2 Verbatim extract from the dyadic phase of the cued conversation with a participant with severe memory problems, J.D. (Answers in italics).

Key: RB = reflecting back, Closed Q = closed question, C. Open = classic open question, Rep = idea unit repeated from earlier in the conversation, \* = number of idea units scored by type of verbal prompt.

The questions and answers in the examples above illustrate the difference in length and content of different types of prompts and the resultant responses. Closed questions produce one-word answers while classic open questions produce more narrative accounts. In the second illustration, J.D. (whose free recall score was one) spontaneously interrupted the researcher's reflecting back to continue the story with more detailed descriptions of the action, a pattern which was observed in other participants. The extracts also show the way in which what begins as a potentially classic open question can be changed to a closed question by offering the option of a yes/no answer or a choice of alternatives at the end, as in: Now you mentioned a rope before...(open). Were they going to use the rope in this scenario? (closed). The scoring protocol demands this is scored as a closed question, a course of action seemingly justified by the fact that the participant's response is short or one word, typical of what would be expected from a closed question despite the potentially 'open' beginning.

### Length of conversations and numbers of prompts

Table 5.6 illustrates the length of the different types and phases of the conversations by word count including the words of both the researcher and the participant. Table 5.7 shows the word count for the instructions for the normal conversation compared with the lengthier instructions for the cued conversation which included a context setting preamble. Table 5.8 compares the number of prompts given by the conversation partner in the dyadic phase of both conversation types.

Table 5.6: Number of words in free and dyadic recall phases of the cued and normal conversations and across both phases.

| Word count                 |        |        |        |       |
|----------------------------|--------|--------|--------|-------|
| <b>Cued Conversation</b>   | Total  | Mean   | SD     | Range |
| <b>FR</b>                  | 10,62  | 708.73 | 376.14 | 1,47  |
| <b>DR</b>                  | 45,78  | 3,05   | 617.92 | 2,27  |
| <b>FR and DR</b>           | 56,41  | 3,76   | 788.36 | 3,15  |
| <b>Normal Conversation</b> |        |        |        |       |
|                            | Total  | Mean   | SD     | Range |
| <b>FR</b>                  | 7,088  | 472.5  | 335.53 | 1,014 |
| <b>DR</b>                  | 18,600 | 1,240  | 492.87 | 1,347 |
| <b>FR and DR</b>           | 25,688 | 1,713  | 665.14 | 2,153 |

Table 5.7: Number of words in the context setting preamble of the cued conversation compared with the word count of instructions in the normal conversation.

| Preamble/Instructions word count |       |       |      |       |
|----------------------------------|-------|-------|------|-------|
|                                  | Total | Mean  | SD   | Range |
| <b>Cued Conversation</b>         | 3,831 | 255.4 | 63.6 | 220   |
| <b>Normal Conversation</b>       | 272   | 18.13 | 4.7  | 21    |

Table 5.8: Number of prompts in the dyadic phase of the cued and normal conversations.

| Number of prompts          |       |       |       |       |
|----------------------------|-------|-------|-------|-------|
|                            | Total | Mean  | SD    | Range |
| <b>Cued Conversation</b>   | 1,337 | 88.48 | 36.76 | 140   |
| <b>Normal Conversation</b> | 514   | 34.27 | 15.31 | 53    |

In free recall, once the mean word length of the preamble and short instructions are accounted for, free recall produced a similar number of words (453) for both conversation types. This indicates that although free recall in the normal conversation produced a larger (though non-significant), number of idea units than the cued conversation (29.3 and 21.9 respectively) they emerged from a similar number of words. It appears that although both conditions result in a comparable number of words being spoken by the participant in the free recall phase, more idea units are elicited when the context-setting preamble is excluded. The dyadic phase of the cued conversation was two and a half times longer in terms of word count than that of the normal conversation and had two and a half times the number of prompts. This is explained by the protocol of the dyadic phase of the cued conversation, which demanded more open questions and the use of reflecting back: longer exchanges which necessarily increased the word count. In summary, though it would be impossible to conduct any conversation without closed questions, using an increased number of non-closed questions and prompts makes it possible to extend the conversation, whereas a concentration of closed questions brings the conversation to a more abrupt end. In particular the use of reflecting back, in which the researcher paraphrases the words of the rememberer without contradiction or addition, enables the conversation to be prolonged even beyond the point where the rememberer appears to dry up.

## DISCUSSION

The results of this study lend weight to the proposition that people with memory impairments recall more about recent experiences depending on the way they are asked, as was conjectured by Wilson (1987) and Baddeley (1982) and add credence to Wilson's (1987) suggestion that it may be helpful to teach those who interact with people who have memory problems to phrase their questions in ways which will potentially enhance recall. These conclusions rest upon the fact that significantly more idea units were recalled in the dyadic phase of the cued conversation - where the emphasis was on open-ended prompts - than in the normal conversation condition, where closed questions were allowed to predominate. Subject to the caveat that idea units are produced as a result of a combination of prompts and verbal exchanges, all types of conversational cues seem to work, but a style which emphasises open questions appears to work best.

Imaginal context setting was introduced before free recall in the cued conversation condition on the basis that it may increase free recall and that this could also have an incremental effect on dyadic recall by providing the basis for more potential cues to be fed back to the participant. In practice this strategy failed. The pattern of recall was the opposite of what was expected. Though not statistically significant, mean free recall was lower when context was set and higher when it was omitted. These relative losses and gains in free recall were offset by correspondingly similar losses and gains in the dyadic phase leading to no significant difference in the conversation types overall. This result tentatively raises the question of whether context setting, in the form it was applied in this study, may not just be neutral but could be detrimental to free recall in a population of people with memory impairment. Further work is needed to investigate this proposition.

The discussion of these results falls into two broad sections. First, the reasons for the lack of effect of context setting in the free recall phase of the study - or conversely the possible memory enhancing effect of *not* applying context setting - as it was done in this study - are scrutinised, followed secondly by an examination of possible explanations for the apparent superiority of the cued conversation in the dyadic phase. Finally, suggestions are put forward which may form a basis for conversation guidelines for those interacting with people with memory problems.

### **Limitations**

The naturalistic conditions imposed by the methodology in order to strive for a measure of ecological validity could give rise to the possibility that recall in the dyadic phase would be adversely affected by participants having already had the opportunity to recall items in the free recall phase i.e. that the more they recall initially, the fewer items are left to be remembered, potentially violating the assumptions of MANCOVA because the dependent variables are related. This issue was addressed statistically, by evaluating the effects of conversation type on each of the dependent variables separately using a Roy-Bargmann stepdown analysis with the results of univariate analyses for each dependent variable also being considered to assist in interpretation of the stepdown statistics. The free recall dependent variable was given priority over dyadic recall in order of entry in the stepdown analysis, both because univariate tests showed that there was a

significant main effect of the conversation type independent variable upon the dyadic recall dependent variable but not the free recall dependent variable, and because the free recall phase preceded the dyadic recall phase in the methodological procedure. Prioritising the free recall dependent variable ahead of the dyadic dependent variable in the stepdown analysis allowed statistical control for any such effect in assessing differences in dyadic recall across the two conversation groups. Thus, in the first stage of the stepdown analysis free recall was tested in a univariate ANCOVA and in the second stage of the stepdown analysis effects on dyadic recall were tested with free recall added to RBMT-11 scores as a second covariate (Tabachnick & Fidell, 2013), with effect sizes for the stepdown analysis being calculated using Smithson's (2003) NoncF3.sps and NoncF.sav SPSS files as recommended by Tabachnick and Fidell (2013).

### **Environmental context reinstatement**

Reliable effects of context reinstatement in enhancing free recall have been demonstrated elsewhere (Godden & Baddeley, 1975; Smith et al., 1978, Smith & Vela, 2001). Therefore before the free recall phase in the cued conversation environmental context-reinstatement was carried out by means of a verbal preamble in which the researcher re-directed the thoughts of the participant to the conditions prevailing at the time. It was speculated that people with compromised memory, such as the participants in this study, may be more inclined to fall back on external context cues to aid recall because of their inability to encode sufficient cues from film they were watching. The results were therefore disappointing because ostensibly it would have been relatively easy to instruct conversation partners in how to use imaginal context setting as a memory aid. It could be argued, of course, that since contextual cueing is unconscious it was being carried out by the participants in both conditions regardless of the instructions of the researcher. All that can be said here is that any predisposition for people with poor episodic memory to fall back on contextual cues at recall was not augmented by the type of context-setting instructions employed in this study.

One explanation for the failure of contextual cueing could be that the type of material used was rich in focal cues leading to the 'overshadowing' or 'outshining' of environmental cues which were either never encoded or were not required at recall (Smith & Vela, 2001). In other work, the use of 'rich' visual material, for example video footage of people's actions (Phillips & Kausler, 1992) and line drawings (Earles, et al., 1996) has resulted in no effect of environmental context for older participants who were deemed to have poorer episodic memory because of their age. Other conditions which may have modulated the effects of context on recall (Smith & Vela, 2001) are the substantial number of input items; the visual presentation of the material and the duration of input exposure all of which have been suspected of leading to the likelihood of 'overshadowing.' Also, anecdotally, many reports of context dependency involve long retention intervals (Fernandez & Glenberg, 1985), where in this case there was a relatively short twenty-minute interval between encoding and recall. Further work could test whether a longer retention period over days or weeks, with context being set, resulted in higher numbers of items being remembered in free recall.

Smith and Vela's (2001) meta analysis, which overall showed the benefit of environmental context reinstatement, was carried out using experimental work with participants with normal memory. Very little has been published on the benefits or otherwise of context setting for people with memory problems. However

older people deemed to have poorer episodic memory solely on the basis of their age (Poon, 1985), have been found in some work to benefit more than younger people from instructions to mentally reinstate the learning context when recalling long lists of unrelated words (Fernandez & Alonzo 2001). Also a cognitive interview study involving older people with mild cognitive impairment showed that context setting was effective as part of the package of cognitive techniques (Wright & Holliday, 2007). Although this is a very small body of work from which to draw generalisations, it is interesting that the results of the study reported here imply that context setting, while it may be a useful aid for elderly people with failing memory and those with normal memory (depending on what is being remembered) it was not effective for the participants in this study who were drawn from a cross section of age groups and whose memory difficulty of various levels was due to brain injury with diverse aetiologies. It is suggested here that the type of material to be recalled needs careful consideration before environmental context setting is employed with people with memory impairment. It may be that learning isolated pieces of information, such as word lists, benefits from external context cues because few cues are available from the focal material, whereas rich multi-modal material, such as that which is drawn from everyday experience, does not because it contains within itself enough focal cues to prompt recall.

A less complex explanation as to why external context cues were not useful in this case could be that it is due to the attentional capacity of the participants. People with brain injury are known to be prone to attentional difficulties of various kinds (Kinsella, 2010). Difficulties with sustained attention - the ability to maintain conscious attention or vigilance over longer periods of time - may be particularly pertinent to the encoding of dynamic material such as a film clip. Also, if we agree that total attentional capacity deployed at any one time is fixed (Kahneman, 1973), processing the complex visual material, presented in this study, may have made such heavy demands on attention, that there was simply a very limited amount left to process incidental environmental cues. Similarly in Baddeley's working memory model, (Baddeley, 2000), the 'episodic buffer' is assumed to have a limited capacity in relation to the computational demands placed upon it, which in this case were relatively high at the encoding stage. The episodic buffer is deemed to employ conscious awareness as a major retrieval strategy, whereas incidental encoding of environmental information is assumed to take place outside conscious awareness. Conscious encoding of the material therefore may have taken precedence over the encoding of peripheral environmental information leading to weak or non-existent external contextual cues. No tests of attention or working memory were applied in this study; therefore, it is impossible to draw anything but speculative conclusions as to the role of these cognitive functions in the performance of the participants. Further work may be able to rectify this.

The lack of context effect could be purely as a result of the small number of participants: a larger study may well have produced the expected context effects. Yet, although this was a small study, it is contended here that the effect of context setting, said to be so robust in the laboratory it must pertain in real life (Godden & Baddeley, 1975), could reasonably have been expected to show some effect, even with such small numbers.

Any one, or combination of the explanations outlined above would provide sufficient reasons for why context setting was ineffective in this study. However, though non significant, the mean number of idea units was higher in free recall when context was *not* set. If this pattern was replicated to significance in a



larger study it would indicate that environmental context reinstatement could be detrimental to this population and is therefore to be avoided. In practical terms this points to a warning that those wanting to enhance recall in their memory-impaired conversation partners should avoid extraneous material unrelated to the episode by getting straight to the point and sticking to the focal material.

In the view of the researcher, the most parsimonious explanation for why context setting may impede free recall is that the experimenter's verbal preamble, as applied in this study, caused a disruption in the expectations of the participants who were readying themselves to recall the contents of the film. Participants in the cued conversation condition where 'context' was set, were initially told 'In a few minutes I will ask you to tell me everything that you remember from the film,' by the researcher, who then went on to set context, using a preamble of between two and three hundred words which began, 'First I want you to put yourself in the situation as it was when you came into the room. What were you thinking about? Were you warm, cold, nervous, confident? Did you notice anything about the room.' They were then asked to recall the contents of the film. In retrospect, it is contended here that this change of tack could have disrupted the retrieval mode - REMO - of this group of participants leading to poorer free recall. REMO is a mental set fundamental to successful recall of episodic material Tulving (1983), during which the cognitive system anticipates and is primed for episodic recall and focusses in on the episode to be recalled (Lepage et al., 2000). When in retrieval mode a portion of the past can be held in mind while the brain refrains from other types of processing which are not relevant to recalling the episode (Conway, 2002).

Converging evidence for the neurological underpinnings of retrieval mode is provided by positron emission tomography studies (Lepage et al., 2000), which have identified sites in the left and right prefrontal cortex, and the anterior cingulate gyrus in which activity is correlated with the maintenance of episodic memory retrieval mode. Even though the participants in the study reported here were told that this was not a memory test, all must have had the expectation that they would be asked to concentrate on remembering the events from the film and to a greater or lesser extent, consciously or unconsciously, prepared themselves to do that. In other words the cognitive system was expecting and preparing for episodic memory construction or recollection - the characteristic of retrieval mode (Conway 2002). At least the participants may have been subject to a precursor to REMO, 'retrieval orientation,' a preparatory state during which the participant engages in content-specific retrieval processes which vary with the information to be retrieved and which is thought to influence the way in which episodic information is subsequently processed (Herron & Wilding, 2006a, 2006b). Retrieval orientation is also characterised by a change in neurologically identifiable brain state as participants are preparing to retrieve information (Herron & Wilding, 2006a). In their neuroimaging study of the neural correlates of the control processes engaged before and during the recovery of episodic information, Herron & Wilding (2006a) found that participants with normal memory who switched between different types of preparatory cues for different episodic information were slower to react to cues compared to those who received the same type of cues across tasks. They conclude that one explanation for this is that adopting a retrieval orientation primes the brain regions involved in the retrieval of the required information. It follows that the corresponding brain states are established via task instructions (e.g. semantic judgements of word meanings are called for, or the orientation of a word displayed on a computer screen).

On reflection, it is argued here, that the context-setting preamble could be seen as acting in the same way as these task instructions, though that was not what was intended. Because of the way in which the ‘instructions’ were worded, the task necessarily shifted the retrieval orientation of the participants from remembering the contents of the film, to being prompted to recall the external context and subsequently back to the film. It is argued here that this state of affairs could have engendered an unanticipated cognitive and neurological shift back and forth in retrieval mode for different aspects of the remembered experience. In other words the context setting preamble may have come as a surprise and caused participants in the cued conversation condition to move away from thinking about the focal events of the film to thoughts about what they saw and what they felt when they came into the room to watch it, and back again, thus causing a temporary disruption in retrieval mode for the specific episodic material they were readying themselves to recount. This account is, of course, speculative. Nevertheless, it provides a theoretical explanation for why external context setting appeared potentially detrimental when it was expected to be of assistance. On the other hand the participants for whom context was not set, did not experience a shift in REMO and stayed focused on the events of the film resulting in better free recall. Subjectively the observations of the interviewer accorded with this explanation as some participants seemed confused by being asked to think about the circumstances pertaining at the time, rather than going straight into remembering the film.

### **Cueing and priming**

Episodic memory is known to be highly cue-sensitive in normal memory (Conway, 2002) and people with amnesia are responsive to cues even though they may feel themselves to be guessing rather than remembering (Mayes & Meudell, 1981), a phenomenon attributed to their preserved ability to respond to priming. This study bears out the proposition that, when cued, even indirectly via a question, people with memory problems, know a lot more than they think they know, at least if the quantity of remembered items is judged by their initial performance in free recall. Additionally, how much they remember can be enhanced depending on the way they are asked. In explaining the results obtained from the dyadic phase of this study, the premise is that the questions and interjections of the interviewer acted as cues. What remains to be explained is why open questions are more efficient at cueing memory than closed questions. The way cueing was carried out in this study differed from that done in most work in the field in that it was done obliquely, by asking questions based only on what the participant had already recounted. Throughout, no extra material related to the film was to be given as a cue, simulating a situation in which the interlocutor was not present at the event being recalled, as would be the case in many everyday situations. Arguably a question asked in this way is not ‘a cue which was present at the time of the encoding,’ in Tulving & Thomson’s (1973) definition, and cannot be, if the interlocutor does not know what cues were actually contained within material. Nevertheless it may be possible that the questions encouraged the participant to make multiple attempts to search his or her own recollections for more memory fragments and to self-generate such cues by initiating the process of ecphory (Moscovitch, 1995) whereby a memory is first generated automatically, however if this initial cue is unsatisfactory or inadequate it is then used to prompt a conscious strategic memory search, “

using whatever semantic or episodic information is available, to enable further stored information to be brought into conscious awareness.” (Moscovitch, 1995 p. 234).

According to Conway (2002) external cues *and* internally generated cues will map directly onto recently formed episodic memories, often potentiating reminders of the recent past. He also maintains that episodic memory can be facilitated through ‘cue-independent’ access which may be made possible through the temporal organisation of episodic memories in the order which they were experienced. Cue independent access, involves a mental reaching back into the very recent past allowing things to ‘pop’ into the mind (Conway, 1992). Episodic memories can then be accessed by cues that map onto memory content by the process of encoding specificity (Tulving & Osler, 1968). This presumably works, at least in part, by the rememberer being cued by the sequence of events being recalled. In this case the repeating back of the words of the participant, during the process of reflecting back, which involves reiterating a sequence of events - for example recalling Ollie trying the door of the saloon is followed by the alarm going off, which is followed by him falling in through the door - could prompt the thought, ‘What did I see next?’

The results of this study appear to bear out the hypothesis that getting people with memory impairments to remember what has happened to them depends on the way they are asked, with open questions being most effective. It needs to be borne in mind, however, that open questions or closed questions can not work in isolation during a conversation. Open questions predominated over closed questions, or not, depending on the protocol for the type of interview. Therefore in both types of conversation both open and closed questions interacted to function as a cue to produce a resultant memory fragment and were useful in ‘mining’ the memory of the participant for extra material not revealed in free recall. The superiority of the dyadic phase of the cued conversation could therefore be simply the way in which the use of an open style of questioning allows for persistence in probing the memory of the rememberer. This perseverance is reflected in the much larger number of verbal exchanges in the cued conversation condition. Using open questions means that the rememberer is not allowed to give up easily but directed to make repeated searches of memory aided by the use of reflecting back - paraphrasing and repeating back of the words of the rememberer - a technique which was omitted from the normal interview. Reflecting back allowed for the continuation of the conversation, even when the rememberer appeared to have exhausted his or her store of memories. Open questions, and reflecting back encourage a more narrative response (demonstrated in the much larger word count of the cued conversation) and a longer answer has of course a better chance of producing extra remembered material. On the other hand continuing to ask closed questions, which in effect means asking the same question over again, gives the conversation the flavour of an interrogation which is uncomfortable for both parties and prematurely brings the conversation to a full stop.

It could also be argued that an open style of questioning may facilitate priming – the recollection of an item based purely on recent exposure even though the rememberer may think he or she has just made a lucky guess. Analysis of the words of the researcher in this study showed that all participants in the cued conversation condition were told as part of the context setting preamble to ‘Report everything even if you are not sure, it doesn’t matter if you get it wrong’ and at least once during the dyadic phase of the conversation each was told at least once to guess if they were uncertain about their recall of events. As has been stated,

people with memory problems may have an accurate recollection, even if they feel themselves to be just saying the first thing that comes to mind (Hamann et al., 1995). In the normal interview condition participants were not told they could report things of which they were not sure, and only one was instructed, once, to guess during the dyadic phase.

### **Focal context**

As well as acting as precursors to self-generated cues, open questions and reflections may have had the effect of re-establishing the focal context of the material being recalled. Focal context setting involves the reinstatement of cues emanating from the material being recalled rather than the peripheral, incidental type of encoding from the external environment. Environmental context, which was ineffective in this study, is assumed to be encoded unconsciously, whereas focal context setting is a conscious process related to the nature of the material being encoded: the richer the material the more cues can be encoded. It is argued here that the effect of open questions and reflections may have been to encourage the participant to re-direct attention to the focal material - the contents of the film itself - encouraging a more thorough search of memory. This process may also have acted to re-establish retrieval mode.

### **Retrieval practice, hypermnesia and the reminiscence effect**

Further work would need to establish whether or not hypermnesia and reminiscence effects, along with retrieval practice are at work in a single attempt at remembering an episode. In the meantime it is possible to speculate that the superiority of dyadic recall in the cued conversation could be entirely due to a combination of these three phenomena, whose effects in any case would be difficult to isolate in an ecologically valid paradigm, such as a conversation. However, because the film could reasonably be split into a series of discrete mini-episodes, it is argued that there is some basis for assuming that retrieval practice at least was responsible for some boost in dyadic recall in the cued conversation and that this was made possible by the encouragement of multiple attempts at recall of parts of the action through the process of reflecting back.

### **Conclusions**

The findings of this study are that conducting a conversation which consists of primarily open questions, including reflecting back the words of the rememberer, is more productive than one which consists of mainly closed questions, which, it is argued here is more analogous to a 'normal' conversation. Theoretical explanations have been put forward for why the style of questioning used in the cued conversation was more effective. However, it may be that it is the freedom to persist in questioning afforded by open questions which produces this result, rather than any particular cueing power of the open question itself. It is argued that the freedom to persevere in asking questions is aided by the use of paraphrasing the words of the rememberer

urging more attempts at recall - even when the rememberer has ostensibly exhausted his or her store of memories.

### **Training and guidelines**

One reason that use of the cued conversation could be useful in rehabilitation is that the onus for promoting recall lies entirely with the non memory - impaired conversation partner, who is the one who must be trained to apply the method. Currently the majority of external and internal techniques commonly used in rehabilitation place the onus for acquiring them and the effort of applying them on people with memory problems, who by definition will have exaggerated difficulty in learning and remembering to use the very methods they are being encouraged to employ. For example they could be trained to use a memory notebook or a voice recorder but these methods are would hardly be appropriate in most informal social exchanges. Recall aids that can be used in the person's own head - so called 'internal' memory aids - are intuitively the ones which may result in the most natural type of remembering. Yet these techniques which involve attempts to enhance encoding or facilitate retrieval (e.g. the making of name/face associations, method of loci and other visualisation methods) are in fact highly artificial and involve using strategies which have to be learned and practised over a long period of time if they are to be successful. These methods involve a large amount of cognitive effort - depth of processing or organisation of material - on the part of the person with the memory problem which would be difficult if not impossible to sustain for remembering a daily experience, such as a visit to the cinema or a meal in a restaurant. In any event, internal memory strategies have a limited usefulness, work best with people with mild memory impairment and crucially, generalisation - the extent to which the person uses the technique without prompting to do so in other areas of their life - is poor (Wilson, 2009).

The cued conversation approach takes the responsibility for remembering away from the person with the memory problem and places it with the person with whom they are conversing who is the one who must learn and apply the technique. Also, since it can be used at any time and in a variety of circumstances it eliminates the problem of transfer or generalisation. The aim is to attempt to provide tools to help 'mine' the memory of the person with a memory problem to the greatest effect: to help bring to the surface every detail that has been encoded. It is hoped that by this means the episode will be better remembered not just once, but in the future and perhaps add to the memory-impaired person's repertoire of reminiscences. Although this proposition remains to be tested, it can be argued that the lack of opportunity to rehearse events in detail soon after they have happened leads to the loss of a chance to strengthen and consolidate otherwise fleeting memories, which then disappear permanently. According to Bjork (1988) the more information is brought to mind in an initial attempt at retrieval the more readily available it is for subsequent retrieval and the key to retrieving an item from memory is to *use* that information by revisiting it. Conway (2002) describes recall of autobiographical memory as an intentional act in which the rememberer enters REMO and actively searches for particular types of knowledge in order to construct or generate a memory. He refers to a complex retrieval processes in which an initial cue is elaborated, prompting an automatic search of memory. The resultant memory outputs are then elaborated further and another search of memory is undertaken. In this way a

specific memory is iteratively constructed by the person doing the remembering. In everyday life when, for example, if there is interaction with family members or colleagues, the result will be more potent cues. In this case “memory construction will be facilitated and access will occur more rapidly” (Conway, 2002 p. 58). It is contended here that this recursive process can be facilitated in people with memory problems by the re-cycling of information through reflecting back and the asking of open questions. This results in a sequence in which free recall produces cues from an initial search of memory; open questions prompt an automatic search of memory and reflecting back facilitates elaboration of the memory output, resulting in more cues being generated.

It is contended here that the use of the cued conversation is a trainable skill which could be imparted in a fairly short time to those wanting to improve social conversation with those who have memory problems: those working in applied contexts with people with brain injury as well as family and friends. Further work could be carried out on the feasibility of this proposition and to refine the methods used. A suggested training course could include elements of education about episodic memory problems, the principles underlying the cued conversation, instruction in active listening and reflecting back, differences between open and closed questions, taped illustrations of the cued conversation being used and practice sessions. In the meantime six tentative guidelines for conversation partners have emerged from this study which are offered below:

Get to the point and stay there:

- When asking about the event to be remembered get straight to the point saying something like ‘Tell me everything about what happened when you went to the seaside yesterday.’ Avoid extraneous observations (e.g. comments about the weather, how the person was feeling at the time, what a good time you had when you went there) and concentrate on the isolated event in time as experienced by the rememberer. Let the person tell you as much as possible in free recall without interruption, and use what they have said, however little this may be to ‘reflect back’ what the person has said, paraphrasing his or her words without contradiction or elaboration.

Reiterate and repeat:

- At pauses in the conversation, ask an open question or ‘reflect back,’ all or part of the events in the order they were presented.

Open is better than closed:

- Avoid closed questions as much as possible in favour of open questions, particularly use ‘classic open questions’ (e.g. ‘what happened when they got there?’ ‘What happened next?’ ‘Describe to me’ or ‘Tell me about.

Persevere and persist:

- Most importantly persevere with the conversation, but focus on the material being remembered. The use of open questions and reflecting back will help with this.

Let them guess:

- Tell the person to guess if they are not certain - that it doesn't matter if they get it wrong and to say what they think, even if they are not sure it is correct.

Keep your own experience to yourself:

- Do not correct the rememberer's version of events or interject your own version of what may have happened. It is their recollections you are interested in. This is social conversation and nothing hangs on the absolute veracity of the recall.

## CHAPTER SIX

### GENERAL DISCUSSION

#### 6.1 Summary and interpretation of findings

The main findings from the two studies on skill-learning were: first that the participants with memory problems acquired a useful, complex procedural motor skill, under conditions which included error-free learning; and secondly that acquisition of a motor skill without explicit instructions, using an error-free paradigm, was not significantly more efficient than learning with instructions. The results of the study using a cued conversation demonstrated that episodic recall of a recent event was differentially affected by the type of questions asked, with open questions being the most effective and that environmental context reinstatement was ineffective in promoting free-recall in this experimental group of people with organic memory difficulty.

#### 6.2 Contribution to knowledge

Overall, the work in this thesis corroborates the results of laboratory studies of preserved skill learning and the effect of cueing on recall in this population and extends research in the field by providing ecological validity for these findings. It makes a contribution to the body of knowledge on the uses of implicit memory in rehabilitation, using approaches which apply to the quotidian difficulties of those with memory problems induced by brain injury.

##### *6.2.1 Skill learning – the touch typing and golf putting studies*

Since publication the touch typing study (Todd & Barrow, 2008) has been cited as adding to the research on the optimisation of skill learning in people with memory impairment (e.g., Powell et al., 2012; Ptak et al., 2013; Sohlberg, 2011; Sohlberg & Turkstra, 2011;). The authors suggest that results from the touch typing study demonstrate that, with extensive training, even people with severe memory problems are capable of acquiring relatively flexible real world complex knowledge which shows some generalisation. Also that encouraging the use of implicit learning by constraining errors in the acquisition of highly proceduralised tasks is a key training variable for people with moderate to severe explicit memory deficits as argued by Sohlberg (2011).

Results demonstrating that the severely impaired participant C.J. showed superior speed and accuracy performance, with no trade off in accuracy as speed improved, serve as an example of how severe explicit memory damage could be a positive indicator of suitability for training in procedural motor skills. If explicit memory function is not available, learning through the implicit route is the only option and competition from explicit processes is therefore naturally excluded leading to better skill acquisition (Poldrack et al., 2001).

Both participants with memory impairment in the touch typing study went on to use the skill in their personal life, providing examples of transfer and/or generalisation, issues which have been problematic in



memory rehabilitation where learning tends to be constrained and inflexible (Glisky, 2005). However, it must be said that touch typing, along with other motor tasks, is of itself relatively immune to problems of transfer and generalisation, because performance of the task is always exactly the same requiring only that a QWERTY keyboard is presented. In terms purely of keyboard use, the hyper-specificity, which is often seen as a negative characteristic of learning in people with amnesia, may be an advantage, with the important caveat that the arrangement of the letters on the standard keyboard does not change.

The participant C.J was highly motivated by the fact that she had acquired a difficult skill which impressed others and she was subsequently taught to use email and word processing software to copy-type and generate personal documents. It is suggested that transfer of the touch typing skill to these tasks was facilitated because her use of the keyboard had become automatic, releasing capacity for training in the more cognitively demanding tasks of learning to operate the computer, which were nevertheless taught using error-reduced methodology. Extrapolating this observation to the area of vocational rehabilitation, it is proposed that, ideally, the motoric aspects of a job, for example assembling components on a production line, should be isolated and taught first, to the point of automaticity, before training in other more cognitively demanding aspects (e.g. passing on messages to the factory stores) takes place. Tasks such as the latter should then be 'proceduralised' enabling them to be taught in an error-reduced fashion, using compensatory aids such as a note-book or check list.

The golf putting study looked for the first time at the proposition that instruction-free learning may help to optimise implicit skill learning in people with memory problems when they are taught using error-reduced conditions. Though results did not show that omitting verbal instruction improved skill learning, it is suggested that this could be because the robust effect of error-free learning, applied in both conditions, masked any effect of not giving explicit instructions. However because there is a need to look for more ways in which implicit learning can be optimised in people with memory difficulty, ways in which this work could be taken forward are suggested below (6.4.).

### *6.2.2 Conversational cueing*

Until now research in the area of cueing and priming, has mainly been confined to the laboratory. The 'cued conversation' study, therefore, makes an original contribution to knowledge by investigating the effect of these phenomena on episodic recall using an ecologically valid paradigm - an analogue of a conversation between two people. It examined for the first time whether questions and other verbal exchanges could act as recall cues. The findings bear out the historic observations of Wilson (1987) and Baddeley (1982), that how much people with memory problems recall depends on the way they are asked and that it may be worthwhile to train their friends and relatives to phrase questions in a specific manner in order to enhance retrieval. Results indicated that all verbal exchanges helped recall, however the amount remembered *was* differentially affected by the types of question employed, with an open style of questioning being most effective.

The results add weight to the proposition that the deficiencies of memory-impaired people are not solely attributable to failures at the encoding stage. Rather, they encode more information than they realise but, in the absence of external cues, lack the means to spontaneously extract it. In Tulving and Thomson's (1973) terms it is available but (without the right type of cue) it is not accessible.

From a cognitive perspective episodic memory involves the encoding, consolidation and recall of a sequence of linked scenes over a short period of time (Mayes & Roberts, 2001). The results of the work described here accord with Tulving and Shacter's (1990) stance that episodic memory is a process which primarily involves the relationship between encoding at acquisition and reconstruction at retrieval. This results in 'ecphoric' recall, the product of both the encoding process and retrieval cues (Tulving 1983). The 'coming together' of this information during retrieval is a dynamic process that he termed *synergy*. Under this paradigm memory involves an interactive processing continuum which can break down at any point. This point may vary between different patients, but the end result is a lack of ability to acquire and recall new information. According to Roediger (1990) a lack of ecphoric synergy during the process of attempting to remember is a characteristic of amnesia: people with amnesia fail to spontaneously slot the initial processing at encoding and the cue together. The results of the study reported here suggest that cueing in the form of questions and verbal exchanges of all types appeared to promote ecphoric synergy in the participants in this study. Further, that conversational cueing may benefit those with more severe memory problems. The RBMT-II (Wilson et al., 1991), used to test participants in this study, has four classifications of memory level, ranging in level of impairment from 'normal' through 'poor' to 'moderate' and 'severe.' Of the participants in this study, two scored as severely impaired, eight as moderately impaired and the rest as normal or poor. When combined into two groups on the basis of their memory level (moderate/severe and normal/poor), both groups broadly doubled the number of idea units they had generated in free recall when cued during dyadic recall phase.

Collapsed across conditions the data show that the mean recall of those in moderate/severe group ( $n=10$ ) in the dyadic phase was 19.5 (FR) and 23.3 (DR) while individually, of those in the cued conversation group, a 'severe' participant, who recalled but a single idea unit in free recall phase, went on to score thirty in the dyadic phase. Another with moderate memory problems scored 22 in free recall, and 44 in dyadic recall. Those with normal/poor memory ( $n = 20$ ) performed better than the moderate/severe group in free recall, but dyadic recall, demonstrating a mean of just 3.7 fewer items, was still productive almost doubling the mean number of idea units recalled overall 31.24 (FR) 27.5 (DR).

The results shown at Fig 6.1 below, indicate that conversational cueing may benefit not just those with less significant memory problems but also to those with more severe difficulties.

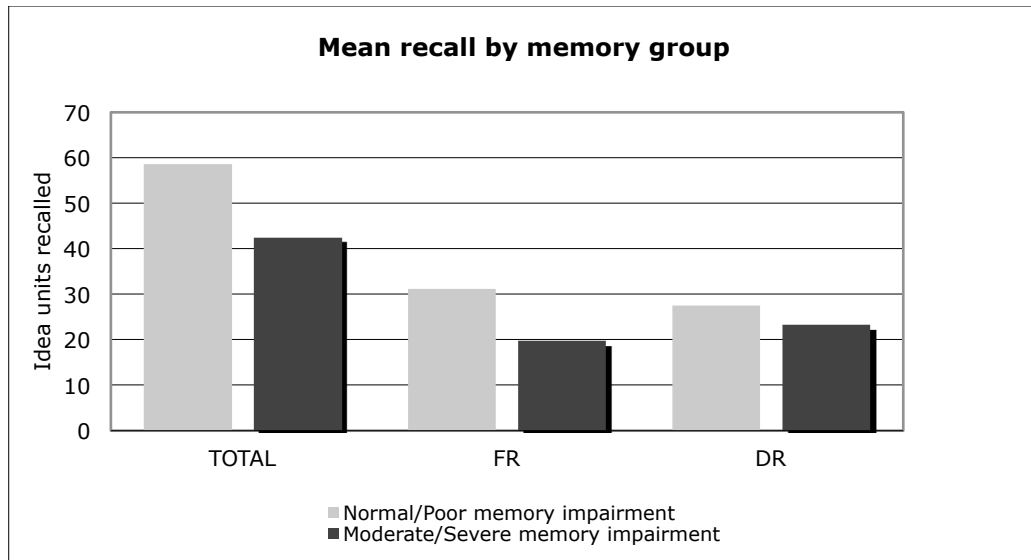


Fig 6.1 Mean number of idea units recalled across conditions by memory group. FR = Free Recall, D.R = Dyadic Recall. Normal/Poor  $n=20$ ; Moderate/Severe  $n=10$ .

### 6.3 Alternative interpretations of results

There appears to be no doubt that dyadic cueing was effective in the cued conversation study. What is more controversial is the extent to which this was made possible through retained implicit memory. Priming refers to an improvement in the ability to respond correctly to a cue based purely on recent exposure and because, under certain conditions in the laboratory, amnesics respond to priming, it is assumed to be mediated through preserved implicit memory (e.g., Warrington & Weiskrantz, 1974; Mayes & Meudell, 1981; Graf, et al., 1984; Yaniv et al., 1995). Was priming in fact at work in the in cued conversation study? An alternative interpretation of the results is that participants were cued through their residual explicit memory and that priming mediated by implicit memory played no role in the process. It is suggested here that the results regarding the moderate/severe participants, reported above, mitigate to some extent against this explanation. Their deficits as assessed indicated that they had less explicit memory available, nevertheless their response to cueing exceeded that of their free recall and was comparable to the normal/moderate group suggesting that in their case, recall was due, at least to some extent, due to priming.

According to Tulving and Schacter (1990) priming cannot be an artefact of the laboratory; it performs a more important role in everyday life than was previously assumed and the requisite conditions for priming frequently occur naturally in the outside world. It is arguably the case that the cued conversation set up these conditions. Firstly in cases of amnesia, under laboratory conditions, participants often feel that a correct response to a cue is a 'lucky guess,' (e.g., Graf, Mandler & Haden, 1982; Mayes & Meudell, 1981; Tulving et al., 1982; Warrington & Weiskrantz, 1974) and successful priming depends crucially on the participant not being instructed to consciously try to remember, but to respond with whatever comes to mind (Graf & Mandler, 1984; Graf & Schacter, 1985). In the cued conversation condition, which favoured an open style of

questioning, participants were *not* instructed explicitly to try to remember, but were asked to ‘Report everything even if you are not sure, it doesn’t matter if you get it wrong’ and the protocol demanded that such questions as ‘Do you remember?’ or ‘Can you recall?’ be avoided because they are closed questions. Secondly, in the course of the conversation, participants were instructed to ‘guess’ if they were not sure. It can be inferred therefore that the methodology of the cued conversation replicated, to some extent, the conditions which have been shown in the laboratory to result in successful priming and that priming played a part in the superiority of the recall scores in the cued conversation condition.

The conclusion favoured here is that in most participants, the likelihood is that the two memory systems were working in concert: that implicit memory may have played but a secondary, but still productive, role, coming to the fore only when explicit memory failed. In practical terms, however, whichever underlying memory systems are responsible, conversational cueing demonstrated the value of persistently ‘mining’ the recollections of people with memory difficulties a process which is facilitated by the use of an open style of questioning. Also of note is that concerns that extensive cueing may result in confabulation were not justified in this study.

#### **6.4 Methodological issues**

Methodological issues arise in conducting research which seeks to investigate real-world, interventions for people with memory problems. These include of control of variables, difficulties in recruiting and maintaining sufficient participants with disabilities leading to smaller scale studies and a consequent lack of statistical power. Problems may also arise from the question of whether a study may be confounded with an intervention when carried out in a non-clinical setting where the objective is individual rehabilitation. For example, should skill teaching be continued if a pre-planned methodology does not appear to be working? In the touch typing study reported here this was addressed by adopting a ‘belt and braces’ approach of applying a battery of validated teaching methods to optimise the chance of success, but it could be argued that this consequently led to a lack of clarity over which individual elements were most effective.

Personal variables, such as differences in levels and types of memory ability, general intelligence and cognitive reserve, can be almost impossible to control in group studies involving people with brain injury. Also, people with brain injury often have other complex cognitive, emotional and physical problems, which affect their functioning from one day to the next, so that performance may vary from one trial to another for reasons unconnected with memory. Arguably these factors call for a more flexible approach to research design in the area of memory rehabilitation. Perhaps what is needed is more recognition that worthy findings can emerge from small studies and that null results can raise interesting questions which may point to future studies.

The study on conversational cueing presented unusual methodological problems, which required a novel approach to the scoring of the recall data. The study relied on Bartlett’s (1932), premise that memory is *literally* a reconstructive process interpreted from the viewpoint of the teller which is unlikely to be veridical (e.g., Loftus, 1991, 2003). Rather people’s memories “are the sum of what they have thought, what they have been told, what they believe” (Lofus, 2003 p. 872). A primary function of the methodology was to represent

an analogue of 'real' social verbal interaction, recognising, in Bartlett's terms that "literal or accurate recall is an artificial construct of the laboratory," (Bartlett, 1932, p.29). Therefore a particular methodological problem was what qualifies as a recalled idea unit for scoring purposes? How the problem was addressed in this study is detailed in the method section of the cued conversation study.

## 6.5 Future directions

It is apparent that rehabilitation studies need to distinguish between efficacy - that is evidence suggesting that an intervention *can* work, usually demonstrated under highly constrained circumstances - and effectiveness i.e. evidence that an intervention *does* work in real life (Cicerone, Langenbahn, Braden, Malec, Kalmar, Fraas, M., & Ashman, 2011) and to decide on appropriate outcome measures. At the time of writing the most recent practice review of evidence based cognitive rehabilitation literature from 2003-2008 (Cicerone et al., 2011) concluded that there is substantial evidence to support cognitive rehabilitation overall, including memory, following TBI and stroke and that this is worth undertaking even years post-injury. In memory rehabilitation it recommends that training in the use of compensatory strategies, including the use of internalised strategies such as visual imagery and external strategies such as the use of notebooks, as a practice standard for those with mild to moderate memory impairment. For those with more severe memory problems teaching the use of external compensations with direct application to functional activities using error free learning, is recommended as are reminder prompting systems such as Neuropage © (Wilson, et al., 2005). The review also indicated that frequency and intensity of memory training were critical factors in improving performance. The majority of the studies reviewed, however, rely on improvements assessed by standardised tests and the authors concede that the evidence regarding improvements at the level of functional activities, or life satisfaction is more limited - possibly because of the short time frame of most interventions and the restricted opportunity to address their application to everyday life. Rohling et al. (2009), in a meta analysis of the effect sizes of the data used by Cicerone et al. (2011) found the results of memory rehabilitation to be "mixed and weak" (Rohling, 2009, p33.) with no significant effect of memory training in studies involving independent groups with pre and post-test conditions and argue the case for a sequential move towards more randomised control trials. On the other hand, while not ruling out 'incidental' improvements on neuropsychological assessment as a consequence of memory interventions Wilson, Gracey, Evans and Bateman (2009), point out that people can make functional improvements in everyday life without gaining points on test scores. They cite the "rehabilitation success" of patient with amnesia who was able to live alone, hold down a job and use compensatory strategies but who nevertheless continued to score at zero on standardised tests of delayed memory Wilson et al., (2009 p149). These authors recommend the achievement of personally relevant goals as an outcome measure in rehabilitation, rather than improvement on test scores, though these do not lend themselves easily to group studies or randomised control trials and they cannot provide systematic data on all problems.

It is suggested here that one way to track improvements over time and to judge the success of an intervention in context, is to increase the involvement of those who interact with people with memory problems in the research effort. Ideally, training in the reinforcement of memory strategies should be offered

as a matter of course to carers, family, work colleagues and employers, who can then apply this in the real world. Feedback from these potential ‘citizen researchers’ via, for example, a professionally curated on-line forum could result in large amounts of useful data relating to functional usefulness and life satisfaction.

### 6.5.1 Skill learning

The researcher opted for touch typing as a task worthy of training after observing the painfully slow and awkward efforts of a class of novice computer users with brain injury to negotiate the keyboard. The reasons for selecting touch typing as an optimal method of training for people with memory problems, rather than ad hoc practice are detailed in the introduction to the study. The choice was also influenced by the fact that efficient use of the traditional QWERTY keyboard, is considered a primary ability in the hierarchy of computer skills. As the principal interface between computer and user (Johnson, 1992) it is a gateway, which allows access to much everyday technology, and, importantly, it, remains unchanged a century after its invention.

The issue of *change*, in the nature of the task or in equipment design, is a major consideration in memory rehabilitation, when trained tasks are aimed at improving everyday life or earning a living. Experimental work has demonstrated that people with memory problems *can* learn under certain conditions (e.g., Powell et al., 2012; Todd & Barrow, 2008). However, in terms of individual rehabilitation it is vital that, given the investment in time and effort, the person acquires a task capable of being employed at least for the foreseeable future. Unfortunately, in the case of assistive technology or computer use this requires predicting which equipment or software will stand the test of time. Over time, frequent changes in software such as the eleven versions of Microsoft Office <sup>™</sup>, which have been released since 1990 (Computer History Museum, 2014) means skills may quickly become out-dated. Assistive technology too is frequently superseded. For example a type of personal digital assistant, selected for its ease of use and commercial availability in a study by Powell et al., (2012) went out of manufacture prior to publication of the work. Because of these fluctuations, and because their knowledge is hyper-specific and does not easily generalise, people with memory problems will need to be re-taught under conditions in which old habits, consolidated through error-free learning and practice, can be extinguished in favour of new routines. Ideally, future work will involve collaborations with technology and software designers to produce sustainable solutions to this currently intractable problem. Otherwise research will be required in the difficult area of investigating ways to effectively overlay new skills on top of old ones.

In other areas, more work is needed into the most efficient ways to teach people with memory problems the types of perceptual motor skills which are not amenable to error-free learning such as juggling (to improve hand-eye co-ordination) and the use of balance and mobility aids. Though results were equivocal, the study reported here on instruction-free acquisition of golf putting may have something to contribute in this field. The study, carried out under error-reduced conditions, was an attempt to further optimise motor skill acquisition by omitting explicit instructions in order to facilitate implicit learning. Interpretation of the confidence intervals showed no difference between instructed and non-instructed groups and it was therefore tentatively suggested that the technique could provide an adjunct or alternative to error-free protocols. This

was a small study and the robust effects of error-free learning may have overshadowed any effect of the instruction conditions. It may be productive to conduct a larger study, omitting error-reduction and using the instruction/no instruction conditions as variables over a longer period of time, and include retention tests at longer intervals.

Participants, in the instruction-free group of the golf study appeared to demonstrate, by their subsequent stating the 'rules of the game,' that explicit learning had occurred during implicit acquisition of the task, replicating the results of Poolton et al. (2005), using normal learners in a golf putting task. More thorough examination of the qualitative observations of all participants should be included in future work.

#### *6.5.2 Conversational cueing*

It is suggested that future research directions in the cued conversation study could proceed in three ways. First, based on the gains in recall in the dyadic phase over free recall of the participant with severe memory difficulty, more single case or group studies, using solely amnesic participants should be carried out incorporating retention tests at longer periods. Secondly studies should be designed with the methodology adjusted to omit the variable of imaginal context setting which in this study proved ineffective. Context setting was included on the basis of its robust history of success in other populations (e.g., Godden & Baddeley, 1975; Smith et al., 1978; Smith, 1988) and several explanations for its ineffectiveness in this study are detailed in the discussion section including Smith and Vela's 'outshining' hypothesis and the possible disruption of retrieval mode (Tulving, 1983; Lepage et al., 2000), engendered by the researcher's context setting preamble.

A third major strand of further studies would involve the training of conversation partners in the cued conversation technique using the guidelines set out in the discussion section of the study. Evaluation of such training courses could productively adapt the methodology of Rayner and Marshall (2003) who found that volunteers could be trained to act as more productive conversation partners to people with aphasia during a short training course.

This work is unusual in the field of memory rehabilitation, in that it involves the training of prospective conversation partners rather than the person with a memory difficulty, an approach already employed in the rehabilitation of aphasia (e.g., Booth & Swabey, 1999; Rayner & Marshall, 2003; Cunningham & Ward, 2003). Because it does not involve effort for the person with the memory difficulty, and because of its apparent effectiveness in the severe and moderately impaired participants in this study it could be especially applicable to those with significant memory deficiencies.

The cued conversation, as carried out in this study, including free and dyadic recall phases represents a way to optimise episodic recall for a person with a memory difficulty just once and in the present time. However, it is hypothesised that the more information brought to mind in this attempt, the more likely it is to be available for subsequent retrievals : that the deeper, more difficult retrieval processes involved may reactivate or strengthen encoding, making the memory more supportive of long term retention (Bjork, 1975, 1988). If this is the case the episode may be added to the repertoire of reminiscences of the person with the memory problem, to be used in the future. In terms of social interaction this may go some way to ameliorate

the problem of the same well-remembered tales from before the injury being repeated ad nauseam to the frustration of friends and relatives.

On the other hand, socially, a drawback to the method is that it focuses exclusively on the recall of just one member of the conversation dyad - the one with a memory impairment. It breaches the subtle rules of conversational etiquette, that a conversation is two way process with the listener contributing his or her personal comments and similar experiences. However, for people with memory problems these digressions must involve attempting to encode new explicit information (the recollections of the other) during retrieval of their own experience - to the disadvantage of both processes. In addition, as far as the rememberer is concerned the recollections of others do not provide cues which were present at the time of the encoding of *their* memory. Therefore they do not provide the similarity between memory traces formed during encoding and cues used at retrieval which appears to be involved in successfully converting a potential memory into conscious awareness (Thomson & Tulving, 1970; Tulving & Pearlstone, 1966; Tulving & Osler, 1968; Tulving & Thomson, 1973).

## 6.6 Conclusion

Wilson (2009) has stated that the best future development for people with memory impairments and their families is that they can access all the help they need. It is argued here that one way to optimise memory rehabilitation is to develop techniques to enhance recall and learning in people with memory impairment which are aimed at family members or volunteers. The use of carers as trainers has been recommended as a model which would reduce time and resources (Sohlberg & Turkstra, 2011), but there is so far little evidence of the success or otherwise of this strategy. However, in a rare published example, carers successfully applied error-free learning to a patient with severe brain injury, having themselves been taught the technique by an occupational therapist (Campbell et al., 2007). It is contended here that carers are an underused resource whose contribution could be maximised via training courses or on-line tutorials. As far as the work reported in this thesis is concerned, once the rules have been grasped, volunteers could teach touch typing, and speed up the process by applying more frequent learning sessions at home.

The cued conversation is a special case in that it *must* be learned by the potential conversation partner. It appears to be a trainable skill, however, and the guidelines set out in the discussion section of the cued conversation study, may be readily grasped during a face to face or on-line training course. While at first sight, 'training to train', may appear to present an additional burden to carers and families, but those suffering stress caused by a lack of meaningful social communication (Boschen et al., 2007) may welcome access to any intervention which may help, even in a small way, to ameliorate this situation.



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APPENDIX III Sample page of golf score sheet (1 of 3).

Pp.....Date.....CNDN.....

25 CMS HOLES MISSED

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Score /50

50 CMS HOLES MISSED

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Score /50

APPENDIX III Sample page of golf score sheet (1 of 3).

100 CMS HOLES MISSED

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125 CMS HOLES MISSED

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150 CMS HOLES MISSED

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Score /50

APPENDIX III Sample page of golf score sheet (1 of 3).

175 CMS HOLES MISSED

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Score /50

TEST PHASE HOLES MISSED

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Score /50

TOTAL SCORE /400

Rules learned during training:

## APPENDIX IV Cued Conversation Pilot Study

An exploratory pilot study involving participants with normal memory in advance of the planned study: **Using conversational cues to enhance episodic recall of a Laurel and Hardy film clip in people with memory difficulty.**

Introduction:

The research objectives of the planned study were : To test the methodology of a planned exploratory experimental study into the recall of a recent episode. The study will compare an open question style using context reinstatement against a ‘normal’ interview with closed questions with no context reinstatement. Recall will be measured by the number of idea units reported from an eight minute viewing of a video recording.

Aims and Rationale of the pilot study:

- ◇ To observe differences emerging between the groups
- ◇ To observe difference in the Free Recall and Questioning (dyadic) phases of the interview
- ◇ To test the efficacy of the scoring system
- ◇ To test the interviewer conformity to the different interview protocols

Four volunteer participants with normal memory, two males aged 43 and 59 and two females aged 60 and 33 (mean 48.75) were allocated randomly to the two groups, i.e. context reinstatement with open questions (Cnd A, Cued Conversation) and Normal Interview with closed questions (Cnd B, Normal Conversation).

Method:

The participants viewed an eight minute video clip from the Laurel and Hardy film ‘Way Out West.’ The clip of the film, on a DVD, was viewed on a computer screen by the participants sitting alone in a quiet room.

Participants were told: ‘I want you to watch the video, then I will ask you to go away and do whatever you want to do for a while. After twenty minutes I will ask you to come back and tell me what you can remember.’ After an interval of 20 minutes they were asked to recall everything they could from the video.

Interviews were tape recorded and transcribed.

Interview protocols:

The protocol for the cued conversation group involved reinstatement of personal context i.e. how the participant was feeling at the time, what they were thinking and doing prior to watching the video. They were asked to put themselves back in time to when they first entered the room and to imagine the circumstances, what the room looked like and how they were feeling etc. and to close their eyes if they wanted to while they were doing this. They were then asked to recall everything they could, regardless of whether they were sure of its accuracy and to guess if they were not sure. The Free Recall (FR) stage was followed by the Dyadic Recall (DR) phase during which the Pp was asked, as far as possible questions ‘open’ questions. No actual cues from the video itself were given.

In the NC condition, no attempts were made at context reinstatement. Questions were as far as possible ‘closed’ or forced choice questions. All questions, in both conditions were based on what was said by the Pp

initially in free recall and subsequently included other material from the Pps answers to questions and prompts.

Scoring.

Prior to the study the video was broken down into idea units with the help of a photographic story board of the narrative, to be used as an aid to scoring. Items from the video which may be recalled were also listed in categories: People, actions, objects, dialogue and 'other.' Each idea unit accurately recalled, or with a near synonym was scored as a whole point. Those recalled, accurately, but more vaguely, were scored with a half point. Idea units recalled by the participants which were not already on the list, were added. Confabulations were noted but not scored.

RESULTS: - Linked to the aims of the pilot study.

- ◇ To observe differences emerging between the groups
- ◇ To observe difference in the Free Recall and Dyadic Recall of the interview

In the NC condition Pps recalled more idea units overall (61 and 68) than Pps in the CC condition (60 and 54). Of the total, those in the NC condition recalled more idea units in the FR phase of the interview (42 and 52) than the CC group (37 and 29). The CC group recalled more idea units in the Dyadic phase (23 and 25) than the NI group (18 and 16). (See Table 1).

Table 1: No of idea units recalled by condition and phase.

| <b>Pp</b> | <b>Cdn</b>  | <b>Free recall</b> | <b>Dyadic phase</b> | <b>Total</b> |
|-----------|-------------|--------------------|---------------------|--------------|
| PJ        | A CC        | 37                 | 23                  | 60           |
| LK        | A CC        | 29                 | 25                  | 54           |
| MT        | B NC        | 43                 | 18                  | 61           |
| AG        | B NC        | 52                 | 16                  | 68           |
|           | <b>mean</b> | 40.25              | 20.5                | 60.75        |

No significant errors or confabulations were recorded.

- ◇ To test the efficacy of the scoring system

Transcripts of the interviews added 12 idea units to the lists which had already been prepared. They highlighted the need for notes to be made of 'mimed' or acted out pieces of remembered information for example 'He did that think with his fingers (mimed).' It is suggested that this is scored as accurate recall as it was in the pilot.

A suggestion was made afterwards, by one of the Pps in the CC condition, that instead of being asked to imagine the circumstances leading up to watching the film, the Pp should have a verbal 'run through' of what happened when they entered the room. For example by saying 'You came in through the door and then I said, sit down here etc. etc.' This idea of a verbal preamble being given by the experimenter was considered worth adopting in the study.

The pictorial storyboard scoring system was an efficient aide memoire and helped with scoring guiding the scorer to the relevant part of the film should re-viewing be necessary. The score sheets worked efficiently.

◇ To test the interviewer conformity to the different interview protocols

Ideally the conversation partner should be naive to the contents of the film. This is not possible here due to practical constraints. Since, in the proposed study, all the interviews in both conditions, and the scoring of the material will be done by one person, there is the obvious danger of cross contamination of types of interview protocol and of cueing of material that the experimenter is familiar with from having viewed and dissected the film clip. Analysis of the transcripts of the researcher's interventions and questions therefore is essential. There is a need for vigilance if the results are not to be contaminated.

Analysis of the transcripts in this pilot study showed that Pps were asked twice as many questions (this includes interventions by the experimenter not necessarily couched as questions) in the Dyadic phase of the CC: PJ 16 questions, LK 14, AG 4 and MT 7.

In the pilot study the protocols were adhered to. In the CC condition the majority of questions were open ended and not forced choice. However, it was observed that the researcher could have probed more and asked the Pps to elaborate more on certain aspects of what was viewed. For example LK (line 29,30) "They went into their comedy routine of, 'You've done this to me, I'm going to do that to you..'" could have elicited more probes later in the interview, which may have led to more recall.

#### Discussion:

This was a very small pilot and was meant to be purely exploratory. Not much reliance can be placed on the amount recalled as we do not know the level of the memory abilities of the people involved.

However some interesting observations emerged. Even though the recall of the NC condition was superior overall (largely due to Pp AG who recalled 68 idea units) a noteworthy observation from the raw data is that the Pps in the CC condition recalled a larger proportion of idea units in the dyadic phase (38.3 % and 46.3%) than those in the NC condition (29.5% and 23.5%), which appears to demonstrate the effectiveness of this mode of questioning. Of course the fact that the others recalled more in free recall may indicate the NC is more effective at eliciting better free recall and therefore leaves fewer items available for recall. This is unlikely to be an issue in the case of memory impaired people whose free recall is notoriously impaired. The superiority of the free recall in this pilot could be due to these Pps naturally superior memory and may have levelled out if more participants had been included. It could also be an artefact of them knowing that they were to be tested and therefore attending to the material more closely and/or rehearsing the material during what was meant to be a 'filled interval' between the viewing and the testing. This is unlikely to be a significant issue with people with memory problems whose recall tends to be morbidly affected by interference. Overall the results suggest that superior recall can be elicited in the Dyadic phase of the CC condition. If this is the case it seems likely that the study will produce similar results in the memory impaired population.

# Sample page of cued conversation study score sheet

|   | Cndn              | A                         | B  |                      | ARRIVE |              |                  |
|---|-------------------|---------------------------|--|----------------------|--------|--------------|------------------|
|   |                   |                           |  |                      |        |              |                  |
|   | MAJOR IUs in CAPS |                           | Items in People, Object and Other may only be scored once wherever they occur. Add new idea units as they occur mark |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |
|   |                   | <i>Actions</i>            |  | <i>Objects</i>       |        | <i>Other</i> |                  |
| e |                   | MEN ARRIVE                |  | Mule                 |        | Dark         | black a<br>white |
|   |                   | TRY TO<br>BREAK IN        |  | Pack on mule         |        | Night        | saloor           |
|   |                   | Creeping                  |  | Candle               |        |              |                  |
|   |                   | Look round                |  | Barrells             |        |              |                  |
|   |                   | Look through<br>window    |  | Hitching post        |        |              |                  |
| s |                   | Tries door                |  | Windows              |        |              |                  |
| s |                   | Look through<br>door      |  | Window sign          |        |              |                  |
|   |                   | Examine lock              |  | Mickey Finn's Palace |        |              |                  |
| 1 |                   | Put candle<br>down        |  | Sliding door         |        |              |                  |
|   |                   | Take padlock off - undone |  |                      |        |              |                  |
|   |                   | Slide door grille         |  |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |
|   |                   | NONE                      |  |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |
|   |                   |                           |  |                      |        |              |                  |



# Appendix V. Sample pages of cued conversation story board 1 and 2/36

1



- ☐ Ollie and Stan arrive at front door of bar where they plan to break in.
- ☐ They find a grille in front of the door
- ☐ Stan removes padlock and slides grille

## 2

- ❑ Stan slides the grille and traps Ollie's fingers
- ❑ Ollie shakes his hand and blows on his fingers



Page 1 to 3 of 28

Recall table

Pp JD Cndn B CC

*John in a minute I'm going to ask you to tell me what you can remember from the video. But before I do that I want you to think back to when you first came into the building here, came upstairs, came into the office here and then we sat down and I read some things out to you and you signed it and I want you to think of how you felt at the time. Were you tired, fed up, anything that was going through your mind at the time. Think about what the room looked like, imagine in detail as far as you can. What did you notice and what were you thinking about at the time.*

I was just wondering what was going to happen that's all.

*Wondering what was going to happen? And then we sat there, didn't we and I read it to you and you signed it and then I said you were to watch the video and then we moved over to the computer you sat down and I started it going. So I want you to think about that and think about what you expected to see, what kind of video you thought it was going to be what it actually was, what you first noticed about it and just try to put yourself back in that frame of mind mentally to how you felt then. Also take your time. It doesn't matter whether you tell me things in the right order, it doesn't matter if they are wrong, if you are not sure about something just guess. There's plenty of time, you will probably find that I will run over things with you a few times in the course of the conversation. So if you feel comfortable with that, when you are ready just if you could tell me absolutely anything that you can remember from watching that video that you have just seen.*

| Ref no             | Transcription  | Idea unit | Slide no | Score |
|--------------------|--|-----------|----------|-------|
| 1                  | <i>Not a great deal at the minute no. I can remember bits and pieces. I don't know the story behind the video I can remember obviously being stuck</i> |           |          |       |
| 2                  | <i>and needing to get up to this building by means of a rope.</i>  | Rope      | 20/21    | 1     |
| END OF FREE RECALL |  |           | TOTAL    | 1     |

*Right. So anything else that you can think of if you think back to what you saw? Who was it?*

|   |                   |         |   |   |
|---|-------------------|---------|---|---|
| 3 | <i>Laurel</i>     | Stan    | 1 | 1 |
| 4 | <i>and Hardy.</i> | & Ollie | 1 | 1 |

2 And you say they were near a building.

|   |             |  |  |  |
|---|-------------|--|--|--|
| 5 | <i>Yes.</i> |  |  |  |
|---|-------------|--|--|--|

3 Tell me a bit more about that.

|   |   |         |     |   |
|---|---|---------|-----|---|
| 6 | <i>It's a building with a shed</i>                                    | shed    | 9   | 1 |
| 7 | <i>and then a balcony and</i>   | balcony | 5/6 | 1 |
| 8 | <i>and one would imagine it was a type of tenement type building.</i> |         |     |   |

4 A tenement type of building. Do you say that because it was more than one floor?

|   |  |  |  |  |
|---|--|--|--|--|
| 9 | <i>Yes it was several floors, yes.</i> |  |  |  |
|---|--|--|--|--|

5 Did you say there were about seven floors?

|    |                            |  |  |  |
|----|----------------------------|--|--|--|
| 10 | <i>No, several floors.</i> |  |  |  |
|----|----------------------------|--|--|--|

6 So you think back and you say it was Laurel and Hardy and there was a building. So anything else there that's going on there? They go up to this building...

|    |  |   |       |  |
|----|--|---|-------|--|
| 11 | <i>And there's a bit of slapstick going on, pulling one another And then one person...Laurel pulling Hardy and vice versa.</i> | Pulls rope<br>Falls over<br>Gives rope hard pull<br>Falls over<br>Tugs rope etc | 27/28 | See 28, 29, 30, 31 below. Scored for more detailed description |
| 12 | <i>hitting one another</i>   | Hits on head  | 29/30 | 1  |

|    |   |      |       |   |
|----|---|------|-------|---|
|    | <i>on the hat</i>   |      |       |   |
| 13 | <i>and then there was a mule got involved</i>               | Mule | 31/32 | 1 |
| 14 | <i>He asked Laurel ...was it Laurel I get them mixed up</i> |      |       |   |

7 It doesn't matter, just say what you think. I get them mixed up too. You can say the fat one and the thin one if you like.

|    |  |               |          |   |
|----|--|---------------|----------|---|
| 15 | <i>The fat one asked the thin one to get the mule, so off he went and got the mule- oh - get the</i> | Gets on mule  | 31/32    | 1 |
| 16 | <i>saddle bag</i>  | Pack on mule  | 1        | 1 |
| 17 | <i>and he obviously got the wrong thing and it moved the mule along</i>                              |               |          |   |
| 18 | <i>which in turn dropped him onto his backside or...</i>   | Man goes down | 33/34/35 | 1 |

8 So let me see if I've got this right. We've got Laurel and Hardy, the fat one and the thin one and they are coming up to this building with several floors on it. You mentioned a balcony ..

|    |   |  |   |   |
|----|---|--|---|---|
| 19 | <i>A shed and a balcony. The conversation was as to the way they were going to get up there from the shed to the balcony - their ascent up the building..</i> | 'Why don't we climb up onto the shed and we can get in through the balcony?' | 9 | 1 |
|----|---|--|---|---|